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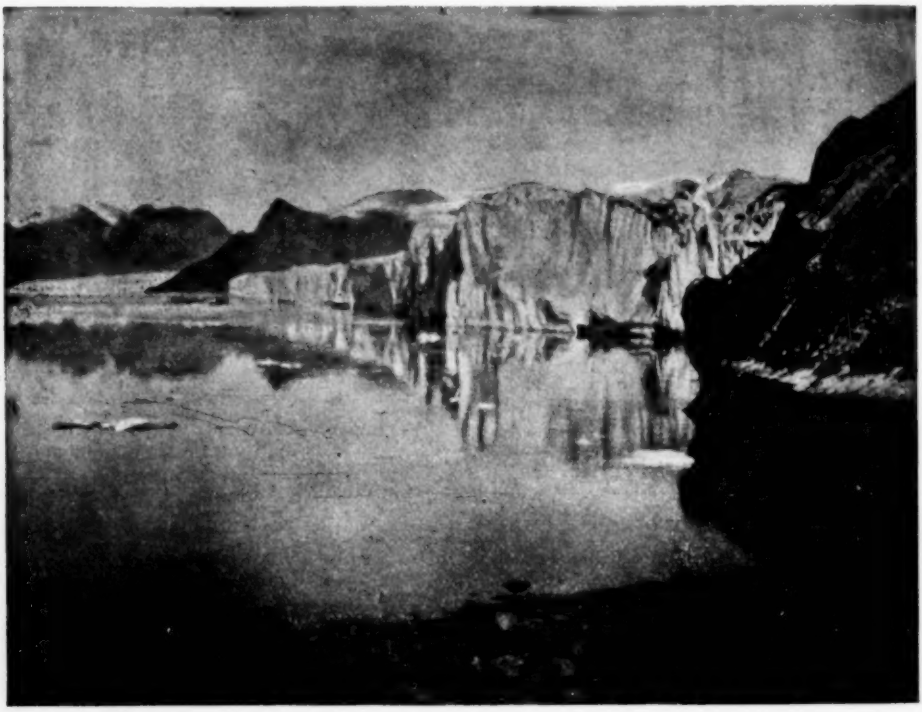
THE GLACIERS OF GREENLAND.

By Prof. ANGELO HEILPRIN.

THE traveler who skirts the coast of Greenland, and sufficiently far from it to permit him to look over the rugged cliffs which almost everywhere dip abruptly into the dark blue ocean, sees above these a long, undulating white crest, beyond which are only sky and conjecture. The white crest glistens awhile in the bright sunlight, elsewhere it disappears in the hazy mist which silently crawls over the landscape and shrouds it in a more or less permanent veil of obscurity. Between the cliffs and bluffs, whose crests rise well into the plane of respectable mountain height, soaring to three, four, and six thousand feet elevation, broad valleys open out to the sea, which here show a carpet of beautiful and inviting green, and elsewhere lie immobile beneath vast sheets of ice which have invaded them and remained possessors of the soil. In some places the ice sheets quite touch the sea, in others they mark a white line across the valley, which is at once the termination of the ice and of the vegetation which crawls up to it. These are the Greenland glaciers, whose tongues the eye readily unites with the interior ice crest, the snow parent to which they owe their birth.

In its fundamental construction a Greenland glacier is much like every other glacier; it neither agrees absolutely with nor differs essentially from the glaciers of the Alpine type. It is only in the matter of size that it can lay claim to special distinction. If the snows of Switzerland and Norway build up glaciers of possibly two, three, or four miles' width, those of Greenland are compacted into ice rivers of from two to five times this width, and exceptionally into streams with perhaps ten or even fifteen times

the expanse. For full two hours we steamed abreast of the great Fredericksshaab glacier (latitude 62°) and along the northeast contours of Melville Bay the eye failed to detect a break in the continuity of the ice wall for seemingly thirty miles or more. Where the eye follows a line of coast for any distance it is almost



MELVILLE GLACIER.

sure to compass all the types of glaciers which belong to the land: the broad and lazy glacial plain, flattened out like a vast and continuous ice slide; the sharply pitched hanging glaciers, which, caterpillar-like, crawl down the steeper slopes at angles of twenty-five to thirty-five degrees; and the deeply fissured crevasse glaciers, whose forbidding aspect only too vividly recalls the wicked ice sheets of the Alps. These types are, however, but the expression of a common structure, modified by local conditions, and set into the particular mold which belongs to each particular region. To assume, as perhaps the greater number of geologists do, that the Greenland glaciers represent, both in their construction and workings, a distinct or individual type, is to do violence to truth.

In the many hours of silent contemplation of these vast ice sheets I often pondered the question of the possible thickness of the ice which was involved in their making. Agassiz's measure-

ment of some eight hundred to a thousand feet in one or more of the Swiss glaciers conjured up visions of vast possibilities in the Greenland giants, yet nowhere could I satisfy myself that even that thickness which was measured in the Alps was to be found here. Perhaps in the far interior the ice may have that thickness and more, but on the tongue sheets and in their terminal walls we found no indications of it. Two or three hundred feet the ice certainly has, but how much more, if anything, I could not determine. Yet the majestic bergs which, flotilla-like, sail out from these slow-moving rivers of ice, and scatter themselves in hundreds and thousands over the blue mirror of the sea, rise in themselves full two hundred feet out of the water, and perhaps not less than seven or eight hundred feet of subaqueous anchorage gives to them that wonderful aspect of immobility which all who have seen it so much admire. Is the exact relation of the fallen berg to its parent still to be determined? Seemingly so, for it is certain that in perhaps by far the greater number of cases the height of the berg bears no distinct relation to the thick-

SURFACE OF VERHOEFF GLACIER.

ness of the glacier of which it at one time formed a part. With my own eyes I saw but few bergs fall or being made, and these were all of insignificant dimensions. Like many of their larger sisters which undergo disruption, they lashed and foamed in the disturbed waters, rising serenely to no definite relation with the parent mass from which they parted.

The older accounts of travelers have invested the Greenland ice with a wicked sublimity particularly its own, which may be

said to be in part an expression of the real terrors of the arctic regions, and in other part a mere fiction of the imagination. What in Nature could be more terrorizing than those impending bergs, fang-armed like the jaws of some antediluvian monster, and rising hundreds of feet in height, which have been made to do service in the annals of nearly all arctic navigators for a full century or more! Yet how many are there who have in fact seen these fantastic symbols of the north? In our two cruises among thousands of bergs of all conditions and sizes we saw only monuments of quiet and impressive beauty—nothing suggestive of near or immediate catastrophe. A berg would tumble here and there, another would groan under the weight of its own dismemberment, and others would, perhaps, be licking up the parts that the sea had torn from them; but whatever it was, the work was accomplished in a peaceable manner, with a seeming consciousness that it had no regret for the results. Nor, indeed, were the results of any magnitude. Travelers have graphically described the commotion in the waters produced by the fall of one of these vast ice mountains, of the cannon-like detonations which were sent out by the snapping of the ice. I should compare the sound more with that of not very intense or even distant thunder, and the agitation of the waters to the churning of a heavily plowing steamship. There are, however, times when the bergs appear in an angry mood. When the after-storm sends them forth from their havens of rest, shooting billowy foam over and through them—it is then that they take on the mane of the lion. The surging waters open out in front of them like the parting in the path of a dolphin, and the bergs swing out triumphantly into the rocking sea. Vain and hopeless would then be the barring of the passage of the moving monster.

The glaciers of Greenland, like their children, have their quiet and angry moods. The flat ice sheets of the north, so firmly consolidated that for miles scarcely a trace of a crevasse is to be found, and whose inclination is such that over almost any part of them railroading could readily be made possible, typify the quiet phase of Nature—wholly different from that which is embodied in the structural form of the majority of the glaciers of the south and of those of Melville Bay, in which the crevasse character is so largely developed. The struggles of Janssen, Nordenskjöld, Whymper, Peary, and Nansen would hardly be intelligible to those whose first efforts in glacial climbing were realized among the solid ice sheets of the north, whose only difficult points, as a rule, are to be found not very far from the ocean front of the ice sheet. With seemingly few exceptions all the larger Greenland glaciers are rifted at their terminal falls, but the rifting, as in all other glaciers, depends upon the slope of the bed, the extent of

the ice, and the general compression or extension that it has undergone. In but few instances did we find the rifting so complete as to debar easy circumvention through zigzagging, and rarely did the crevasses have a greater vertical plunge than from thirty to forty feet, or a width exceeding ten or fifteen feet; indeed, by far the greater number were of insignificant depth and breadth, offering little difficulty in their passage to the mountaineer provided with a glacial axe.

Our first attempt to scale a Greenland glacier was made on one of the minor ice sheets debouching on the northern face of Sonntag Bay, in latitude 78°. We had with us a steel-shod Hudson Bay toboggan, on which we loaded some two hundred or two hundred and fifty pounds of traveling impedimenta, and which

TERMINAL WALL OF VERHOEFF GLACIER.

we had hoped to be able to drag with us. We had selected this glacier because from our anchorage it presented to the eye an attractively gentle slope, which was apparently interrupted by but few crevasses, and a terminal ice wall of but insignificant height. Approach to the ice border soon showed, however, how erroneous had been our perspective. The ice wall, instead of being fifteen to twenty feet in height, as we had assumed, in reality rose to the respectable proportions of some sixty feet, over which arched a dome of graceful and even curve. In a few minutes some of our party had cut their way to the top, but it was made manifest that any attempt to draw our sledge over would only result in disaster to it, and we accordingly abandoned the enterprise. We repeated our efforts still the same night on a

larger but more auspicious-looking glacier, and without difficulty, by climbing over the scanty lateral moraine, reached the middle of the ice. The surface, as in nearly all the Greenland glaciers, was almost entirely destitute of rock *débris*, the sparsely scattered bowlders which in a broken, zigzag line tottered over the flanks of the ice sheet scarcely revealing the structure of a moraine. Two miles in advance of us the ice was solid, with only knife-edge cracks to indicate where it had parted and to mark the positions of possible past crevasses. It fell easily from the center to

LOOKING DOWN INTO THE SUN GLACIER FJORD FROM THE ICE CAP.

either side, describing that symmetrical dome which was apparent from the water front; seaward it descended with so gentle a slope that over long areas it appeared to the eye only horizontal, and elsewhere the gradient could not have exceeded five degrees. Over this surface the toboggan could be drawn without difficulty, and so few were the hummocks that guy-lines could readily be dispensed with. We were still in the cooler hours of night, or rather of the "day of night," and the sun had made but little impression upon the surface. Here and there the crisp, granular ice showed symptoms of early dissolution, and an occasional water pool marked progress to the gradually advancing hours

of true day. A few foxes ventured near our tracks, and some crows winged their way landward, but these were all the signs of animal life that gave movement to the landscape. About two miles from the ice front a great pyramidal rock mountain or *nunatak* split the glacial stream, causing it to swell into gently rising waves and crests, which mounted terracelike one above the other, without, however, materially breaking the continuity of the surface. We found progression over this billowy surface slow and fatiguing; it was difficult to hold the toboggan in position, as the steel runners gained no purchase upon the adamant polish of the ice. It swayed from side to side, undulating like the fins of a fish, and keeping us in a constant state of adjustment. As the slope increased at an elevation of about fourteen hundred feet, crevasses gradually took the place of the fissure splits, and it was found advisable to make use of the rope. We tied ourselves together in single line, keeping about twelve feet apart. There were few crevasses of greater width than the length of our toboggan, and most of these were of insignificant depth, yet there was enough danger in them to warrant a sharp lookout. The snow bridges were particularly treacherous, and their presence was sometimes only made known through an unexpected plunge. Cautiously avoiding these so far as it was possible, and the numerous ugly holes which only too frequently interrupted our course, we finally reached the basin, eighteen hundred feet above the sea, out of which the glacier emerges. We had accomplished our mission; the great glacier lay all below us, and above were only the sky and the upper snow fields which tirelessly fade off to unite with the sky.

A pleasanter ice party than this one can hardly be conceived. With a temperature that was neither warm nor cold, and with just sufficient point in it to give to it that exhilarating quality which impels to work; with a lingering midnight sun sending its warm illumination through a seemingly endless rift of clouds and bergs; a mountain and ocean panorama of almost matchless grandeur around you; a solitude immeasurable and undefinable—these are the elements which united in an exercise to make it forever memorable.

A few days after this first experience we were called upon to do a piece of glacial work the memory of which, unfortunately, associates itself with one of those sad incidents of travel which are seemingly destined, from time to time, to break upon the rugged path of exploration. When all but ready to leave the icebound northern shores for the more hospitable havens of the south, whither we had hoped to convey, unbroken by disaster, the untarnished record of a most successful exploration, intelligence was brought to our quarters that a member of our party

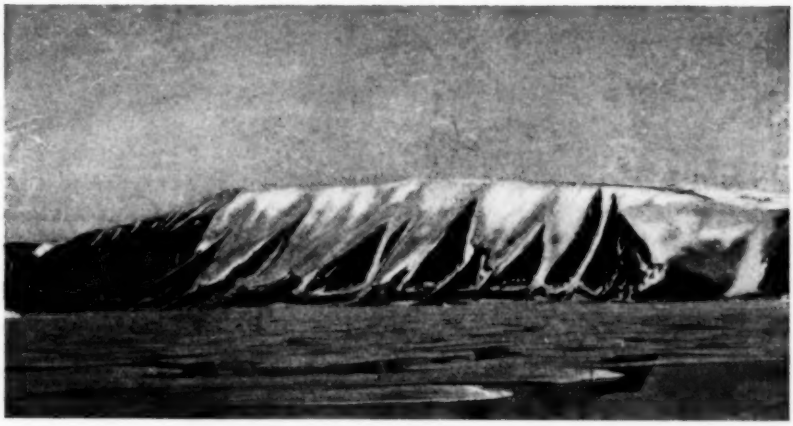
was missing. Mr. Verhoeff, mineralogist of the North Greenland party, had made a final excursion after new rock specimens, and from this search he never returned to meet his associates. It was to ascertain his fate that we were again summoned to those icy fields and domes whose first acquaintance we had but

CROSSING A GREENLAND GLACIER.

recently made. We suspected that our poor friend had attempted a traverse of one of the many glacial sheets which tumbled out into the sea and that disaster had overtaken him in his lonely tour. Accordingly, we instituted a close search over mountain top and valley, and day and night peered among the ice pinnacles for possible traces of the missing man. Our first search was made on the great glacier, since named the Sun Glacier, which cuts the eastern extremity of McCormick Bay, and parts the dry land which in the summer season bounds both the northern and southern shores. It was early in the evening of the 19th of August, when the elevation of the sun still marked about twenty degrees above the horizon, that we again entered the shadows of the same granite cliffs over which, only a few days before, we had so joyfully passed after our meeting with Mr. Peary on his return from his memorable journey. The scene had changed. The deep cañon, along which the eye could follow the long, lazy line of glacier for a distance of twelve to fifteen miles to its mother ice cap, looked bleak and forbidding; there was no longer that charm of the unknown about it which attracts when all Nature smiles with success. A dark cloud had settled over the landscape and for a time closed out its joys.

We approached the front wall of the glacier with caution and almost in silence, fearing lest any percussion might too hastily precipitate some of the tottering masses which were "calving" their way to sea as bergs. Like the snowy avalanches of the Alps, which are at times called to life by the clapping of the hands, so must these ice masses of the north be left to their own peaceful slumbers. Once overturned, there can be no forecasting of the commotion that might follow. A turn or two may end the scene, or it can be that it has hardly begun before the water is churned into foam.

Cutting our steps into the dome-shaped lateral margin of the glacier, we soon gained the surface, upon which walking was fairly easy and comfortable. An effort to reach the opposite side was frustrated by the numerous crevasses which cut into the median portion of the ice, and about which we were obliged to wander in a tortuous, zigzag line. Generally, however, we managed to keep on a united body, or where the fissures were of but insignificant width. For some distance the surface of the ice kept disagreeably hummocky, but after passing a feeding glacier it



Hanging Glacier of Herschel's Island.

spread out in an almost horizontal glistening sheet, admirably adapted for sledging purposes and of necessity for pedestrianism. The crevasses became less and less numerous, and ultimately ceased altogether, so that a traverse could be made in any direction. A narrow, remarkably straight, and evenly defined medial moraine, more in the nature of a dirt band, with angular blocks scattered over it—so like the "archaic" illustrations which figure in the works of Forbes and Agassiz and in other old-fashioned books of geology—occupied the central axis, stretching off upward to the limit of vision. As in all the other Greenland glaciers which it was our pleasure to explore, there were no really

large blocks in the moraines, and there was a complete or nearly complete absence of glacial tables and pyramids. Here and there low mounds of gravel and stones heaped themselves up in beehive-like masses, such as have also been found on the surfaces of the glaciers of Alaska and Spitzbergen, and occasional impacts had also thrown the ice into deformed caps and rafts. There were no ice rivers worthy of the name, and such channels as still marked the courses of surface waters were of but insignificant extent.

Had our mission been different from what it really was we might have said that this glacial traveling was truly delightful. With all the beauty of the ice fields of Switzerland, and that charm of pedestrianism which an unexpected and varying change of scene carries with it, we had here the advantage of the

GLACIER DEBOUCHING ON PLAIN.

many hours, the consciousness that a journey was not limited to any arbitrary separation of day from night. It was all day, albeit the sun shone for only a paltry few hours. For some time angry-looking clouds had been gathering about the blackened granite crests; the side cañons poured out their fleecy hosts, and before long the wild spirits of the mountains swept demonlike across the valley of the glaciers. The few lazily falling flakes which for a half hour or so had portended evil were before long replaced by blinding sheets of snow, and for a long time, save in its elements, Nature ceased to exist. The landscape was completely blotted out from view. We were not prepared for this change, and the cold wind stung mercilessly wherever it caught an exposed surface. We muffled ourselves as best we could in our not over-generous garments, but yet it was not all solid com-

fort. Fortunately, the storm was of only short duration, and in its wake the landscape rose resplendent in its new garb.

We had now penetrated up stream about five or six miles, and had ascended probably six hundred or seven hundred feet in that distance. At three o'clock in the morning we started upon our return. We had seen nothing, and no sound, save the echoes from the beetling cliffs of granite and trap, which here rose in impending masses two thousand five hundred or three thousand feet above us, responded to the oft-repeated shouts to which we gave utterance.

The general aspect and features of the Sun Glacier we found repeated in a still more gigantic ice sheet, the Verhoeff Glacier, which bore the final traces of our unfortunate associate and buried in its bosom the forlorn hope which carried our search for upward of seven days and nights over mountain, snow, and ice. This glacier measures two miles across its terminal wall, but in its middle course, where it is split by a giant *nunatak* rising hundreds of feet above the glistening sheet of ice, it expands to fully twice this width, and then recalls the broad *mers de glace* with which, as miniatures, we had become acquainted in the ice fields of Switzerland and Scandinavia. But here we have the flat united ice mass, with only a suggestion of crevasse to remind one that the ice is a moving body, tearing itself apart and then uniting; all appears firm and stationary, except small rills, which in serpentine courses cut shallow troughs into the surface and musically wend their way to lower levels, ultimately to join the sea. To the eye the main part of the glacier appeared almost absolutely horizontal, and probably it was the flattest of all the sheets that we examined. We were unable to determine the rate of motion, but doubtless it was exceedingly slow, perhaps averaging not more than twelve to fifteen inches in twenty-four hours. In the Sun Glacier we had determined a movement of some seven or eight inches in as many hours, but this was in a part of the glacier where the ice was badly cut by crevasses and in its more rapidly moving lower section. In some of the minor glaciers of the same region we could determine no motion at all, and possibly at that time they had come to an almost absolute standstill. While no detailed observations on the motion of the glaciers of northern Greenland have as yet been made, and therefore no safe deductions can be drawn from the fragmentary records that are now before us, it would appear, nevertheless, almost certain that the majority of the northern ice sheets are much slower in their motion than those of South and Central Greenland—a condition, indeed, that might have been inferred from the conditions of climate which govern the several regions.

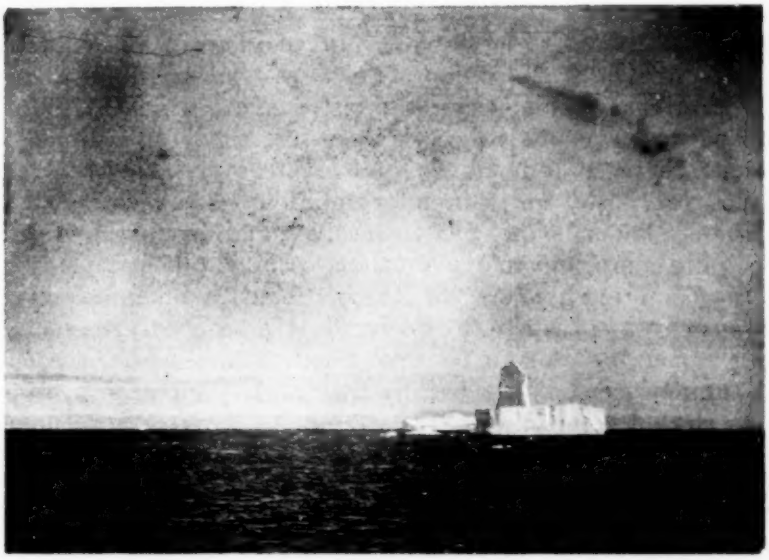
The Verhoeff Glacier presented one aspect in its existence

REMARKABLE DOMED GLACIER IN INGLEFIELD GULF.

which was new in our experience. This was the wealth of vegetation upon which it trespassed and which in part took possession of the icy sea. The spot whence we mounted upon the ice, and where the lateral moraine was discharging its cargo of rock *débris*, was a true garden spot, luxuriant with its growth of grass, and smiling under its garniture of poppies, chickweed, potentillas, and gentians; butterflies flitted about in the bright sunshine, whose genial warmth recalled memories of a distant south. Where the great *nunatak*, rusty in its coat of lichen, threw off the main stream into two broadly diverging arms, the charms of glacial scenery were brought to their fullest height. There, in the midst of

the ice, resplendent in the vigor of its own coloring, was a garden of grass, moss, and wild flowers—a veritable oasis in an ice wilderness. Fruitless would be the effort to depict the beauty of this scene, so wholly magical and weird did it present itself to the eye and mind. The long tufts of grass were twelve to sixteen inches in height, and all about were a wealth and profusion of flowers which would have done justice to the landscape of the full tropics.

Thus, in its quiet mood, does the Greenland glacier reveal itself in a form wholly different from that which the imagination paints it—so different, in fact, that one is tempted to ask, Does it conform to the conditions of existence which have made glaciers



DETACHED FRAGMENTS OF GREENLAND GLACIER. The Watch-Tower Berg.

elsewhere? It unmistakably does, and these conditions have shaped all the forms of glacier, from the tiniest to the largest, from the quietest to the most wicked, to which the region has given birth. Probably all the forms of glaciers that exist in the world are represented in Greenland, and none are found there which might be said to embody a type of structure that is unknown elsewhere. Such as they are, they are but the remains of far more extensive ice sheets which, at no very distant period back in time, plowed far into the ocean deep, shaped much of the contours of the existing land surface, and perhaps even carved a relief of mountain and valley. The traces of past glaciation are everywhere apparent on the barren or uncovered shores, and troughs or water channels, thousands of feet in depth, bight deep into the

areas of continuous drift. How vast, manifestly, have been the changes which marked the landscape during and since the period of greatest ice! The period of recession seemingly still continues, but how far the results of this recession will extend can not be told.

The insignificant development of the ice cap, in its relation to the large glacial streams which radiate off from it, is so striking a peculiarity in some parts of Greenland as to have suggested the suspicion that many of the existing glaciers are merely relics of the great Ice age. Bessels, the accomplished scientist of the Polaris Expedition, indeed, gives voice to this feeling in explanation of the by no means insignificant glaciers of Herbert and Northumberland Islands, lying somewhat north of the seventy-seventh parallel of latitude, which descend from an ice cap of eighteen hundred to two thousand five hundred feet elevation. It did not appear to him probable, or even possible, that the comparatively feeble accumulation of snow which is found at this elevation could originate ice streams of the dimensions which are there found. The facts, however, show that there is no real basis for this interpretation. The snow covering of these islands belongs to themselves, and, feeble though it be, it is quite competent to explain the associated phenomena. Many of the "hanging glaciers" of Herbert Island, which descend over slopes of some thirty to thirty-five degrees, are so attenuated in their upper parts as to be almost extinguished before reaching the summer ice cap; yet basally they rapidly increase in dimensions, so that before they finally terminate they measure not less than forty to fifty feet in thickness. The slowly accumulating snows descend over the first-formed layers, whether by sliding or otherwise, and help to build up the base while they thin out the top. In all essential respects these hanging glaciers are identical in structure with the larger streams, and it is only in their narrow connection with the ice cap that they at all differ. I am indeed convinced that some of the minor glaciers have been formed without the assistance of any ice cap or of the accumulated snows of a *névé* basin; for such streams, which are seemingly not very numerous, the designation of ravine or *couloir* glaciers might, perhaps, be advantageously used.

Briefly recapitulated, the glacial phenomena of Greenland are the phenomena of all other glacial regions; they are not illustrative of new forces and involve no explanations that have not already been made familiar through the teachings of other countries.

PREPARATION FOR COLLEGE BY ENGLISH HIGH SCHOOLS.*

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THE times in which we live are in many respects unlike any which have preceded them. New professions have arisen, old ones have lost their prominence; we live more in the present and less in the past. Recent investigations and discoveries in pathology and bacteriology have done much to increase the respect for and confidence in the practitioners of modern medicine, and have made of modern surgery almost a new science. Quacks may be as numerous as ever, but they rely for patronage upon the ignorant and credulous. The legal profession has taken no backward steps. But with those who undertake the formation of opinions, both spiritual and temporal, the condition of affairs is in many respects different. All the great questions relating to the welfare of the modern intellectual, social, and political world are now being brought up for discussion, and the traditional answers to them are no longer convincing or satisfactory. In the lack of respect for authority, which is so marked a characteristic of the present time, no person's mere dictum is obeyed, or accepted as true, unless he has the power to enforce or the ability, through knowledge, to establish the truth of his statements.

Journalism to-day does much of what was wont to be done by the clergyman and the schoolmaster. While there is no diminution in the respect paid to the sacred office of the preacher, his teachings upon doctrinal points are received *cum grano*, and each one for himself modifies pulpit teachings according to his own views. The world has become more liberal and tolerant. Material of which martyrs were wont to be made is becoming less and less abundant. The parson is no longer the chief source of supply of ideas, social, moral, and political, and is no longer *ex officio* chief man of the parish.

So, while the teacher of secular learning holds as teacher a higher place than ever before, yet, when he undertakes to act as adviser and tries to lay out a course of studies, his dictum does not obtain that confidence which it used to obtain. There arise doubts as to the soundness of the advice given, and suspicions that time and labor may be wasted through misdirection.

In elementary schools, and in technical and professional schools, the ends to be attained and the methods of attainment

* An address delivered before the Massachusetts Association of High and Classical School Teachers.

are comparatively clear and well defined. But the higher institutions of learning, which claim to train youth to engage to advantage in the struggle of life, to compete with their associates, and not only to carry off the prizes, but also to be examples of intelligence and refinement—these institutions, which claim to give what is expressed by the terms culture or a liberal education, find to-day a by no means unanimous agreement as to the best method of producing these results. Many a graduate, while thoroughly loyal to his alma mater, in looking back upon his college studies and considering their effect upon himself, has doubts as to the efficacy of some of his courses there, and questions with himself whether, were he to begin life again, he would, could he *mold fate* to suit himself, go over the same courses again. The advanced student of to-day knows pretty well what kind of instruction he wants, and will go where he can get it. The old, well-worn, and somewhat narrow path trod by his fathers does not satisfy him, and his demand for a change has brought about discussions which, if they have not yet found any practical solution, have at least changed and enlarged the prevailing view of the meaning and aim of a liberal education.

In the attempts at readjustment of the traditional college curriculum the principal attacks have been made, and it seems to me wisely, against the position of Greek in that curriculum. Individually, I have no feeling against Greek in its proper place. I suppose I do not know very much about the language, having like most graduates dropped the study as soon as possible in the college course, and having had little to do with it since. But for that very reason probably I prize what little knowledge I may possess of the subject in inverse ratio to the amount I have. And yet I can not but feel that if one half of the time I spent in studying Greek had been devoted to the study of my own language and the other half to physical labor, sawing wood, for example, I should have been happier at the time, should have had a better physical development, and very probably should never myself have realized the deficiency in my mental equipment.

Greek and Latin were prominent studies in the early European universities because these universities were ecclesiastical corporations; and when Christianity was first established by law the services of the Church were conducted throughout the western part of Europe in the language of those countries at the time, which was a corrupted Latin. After the Roman Empire was overthrown and Latin had ceased to be the language of any part of Europe, the reverence of the people still preserved the established forms and ceremonies, and the church services were still conducted in Latin. This necessitated the study of that language by the priests, so that, from the beginning, Latin made an essen-

tial part of a university education. Both Greek and Hebrew were introduced later, when the Reformers found the original text more favorable to them than the Latin translations.

Greek and Latin thus introduced into the college course have maintained their prestige unshaken almost to the present time, and, having taken such high rank in the college course, the fitting schools have been compelled to arrange their courses to meet the demands of the colleges; so that till quite recently the curriculum of most secondary schools was composed mainly of three studies, Latin, Greek, and mathematics. An English teacher of classics of the present time, speaking of the head master of the school which he attended as a boy, says: "The doctor was a noble type of the old-fashioned English head master. He had a loathing for all scientific study, was utterly ignorant of modern languages, English literature of the day to him was non-existent, his lectures smacked of the last century with their long modulating periods and pauses Ciceronian. All information, historical, antiquarian, geographical, or philosophic, as connected with the classics, he regarded with contempt; any dunderhead, he considered, might cram that at his leisure; but it pained him to the quick if a senior pupil violated the Porsonian pause or trifled with a subjunctive. 'A word in your ear, doctor,' said an Oxford examiner once to him, 'your captain, yesterday, could not tell me where Elis was.' 'I looked horrified,' said the doctor in repeating the circumstance. 'I looked horrified, of course, but on my word I did not know it myself.' From his point of view a boy's chief aim in life was evidently to spend years in studying etymology, syntax, and prosody, and still other years in trying to write Latin verses, a thing which Cicero himself could not have done well."

The classical craze never obtained so strong a foothold in this country as in England, and it might be difficult to find, especially at the present time, any head master in America to whom the above description would apply, and yet I have known some, a composite photograph of whom would show many of the old doctor's prominent characteristics. Dr. Gardner, for many years the head master of the Boston Latin School, one of the largest and best fitting schools in this country, was not a mathematician, and whether or not well versed in modern languages, including English, he never wasted much time in teaching those subjects to the boys. But woe to the boy who did not know his Latin grammar from cover to cover; who could not write his Greek accents as readily as cross his *t's* in English; who had forgotten one of the irregular verbs; or who could not detect an Ionic or Doric form long before he knew why it was used, or whether or not anybody ever used it except on special occasions for special purposes!

As to science, our knowledge of that was only in its special application to the manly art of boxing, and we always supposed that, athlete as he was, he had enough of that to meet all the requirements of his position.

The author just quoted further says, "Be the condition of other branches what you please, the melancholy fact stands that the classics are taught in such a way as to benefit only those who by superior talents or inordinately long continuance at school eventually emerge from the darkness overhanging their elementary training." Of his own class he says: "Of one entire half of their long school probation the majority carried away no intellectual memento. Upon that half had been brought to bear the most expensive part of the educational machinery; masters of arts instead of ushers; clergymen instead of laymen; dictionaries and lexicons instead of copy books and slates. There had been no lack of sowing, but there had been no reaping; the ground had been well harrowed and the seed had been watered plentifully and with tears. Many of his associates who had no special calling for a sailor's life had entered the Naval School, with the mere view of escaping a life of Latin and Greek drudgery on land."

The original design of the colleges in America was the training of a learned clergy, and the ancient languages naturally and properly constituted a main feature of the college curriculum. The best secondary schools naturally were classical schools. The heads of these schools were chosen on account of their classical ability, and in these schools the ancient languages were taught by the ablest and best paid instructors, while the teaching of modern languages, mathematics, and science was generally intrusted to subordinates. From these conditions it is easy to see the evolution of the belief that a liberal education meant a classical education, a knowledge of ancient languages and literatures.

The college requirements for admission, the traditions or superstitions of the past, and the inclinations of those in charge of secondary schools have all tended to maintain and strengthen this view. At a time when the only opportunity for advanced study was offered by institutions which made the classics the principal feature of their instruction, it was natural to measure all learning by the classical standard. To do so to-day is pedantic if not foolish. And yet with the prestige of age and tradition, aided perhaps by the somewhat different class of pupils who attend the strictly classical schools, there pervades these schools a sentiment of superiority which possibly enhances the dignity and honor of the instructors therein.

Now, if there is any such thing as a pedagogical hierarchy, at the very head should be placed the successful teacher of English;

that teacher who, combined with the requisite knowledge, has the ability and inclination to endure hard work and drudgery; who has, in short, the many and rare qualities necessary to give to pupils a good knowledge of their own language, so that they can speak and write it readily, forcibly, and correctly.

One of the principal arguments in justification of the prominence given classical studies is their efficiency in inculcating correct theories of the general principles of language, with the ultimate object, of course, that the student be well versed in his own language, as he never expects to speak or write Greek or Latin. Now, if the study of Greek and Latin does give to the student ability to speak and write his own language readily and correctly, all honor to them. If as good results may be obtained by the direct teaching of English, or indirectly by means of the modern languages, then this chief argument in favor of Greek and Latin loses much of its force. I am inclined to the opinion that good results in English may be obtained by a capable instructor through the medium of almost any subject, and that more depends upon the teacher than upon the subject. Even mathematics, which is not generally taught with special reference to English, may be made to have much influence upon that branch. It is beyond question that where there is not clear, logical thinking, there can not be good speaking or writing, and I have found that apparent deficiency in mathematics is often due to the pupil's inability properly to express mathematical facts which his mind clearly comprehends.

Good teachers of English are not easily found, and as to the practical effect of classical studies upon the student's English, the Board of Examiners of Harvard College, who last year made a careful examination in English of one of the classes, say in their report that "the reflex influence on the student's English of translating Greek and Latin into the mother tongue seems, when subjected to a practical test, to amount to nothing."

Till very recently but little preparation in English was required to pass the college entrance examinations, and consequently preparatory schools neglected that subject; but of late, to meet special requirements in it, the fitting schools have been obliged to give more attention to English. And yet the board of visitors report that of the present Sophomore class of Harvard College, on the entrance examinations only two per cent passed with credit in English, forty-seven per cent were conditioned, and twenty per cent failed to pass the examination. The causes of this may be that the college examinations are not in harmony with the teaching in the preparatory schools, or that the teaching in the fitting schools is not good or is neglected for want of time. In the leading school in Boston for teaching shorthand

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writing the pupils are mostly graduates of high schools. The principal of that school tells me that the most serious obstacles which these pupils meet in their study of shorthand is their inability to spell correctly. The condition of affairs is well expressed by a parent who, having seen on his son's school report eighty per cent in French and forty per cent in English, wrote on the back of the report for the teacher's inspection, "This seems to indicate that, in addition to any blame to be attributed to the boy, there is something wrong elsewhere."

Is it well to fit boys for college so that they may pass the entrance examination with honors in Greek and Latin, and get conditions in English? Would these boys of their own free will, if competent to judge, desire to offer the maximum requirements in Greek and Latin and the minimum in English, modern languages, mathematics, and science? Have not pedagogues, as a class, exposed themselves to the just criticism of being pedantic, dogmatic, and influenced too much by the example and traditions of the past, and possibly also by their own personal tastes and abilities? Are they at present fully in sympathy with the demand of the American civilization of to-day?

It is foolish to deny that there is much that is instructive and ennobling in Greek literature, or that the study of the Greek language is beneficial to such as desire to study it. Greek grammar is the delight of grammarians, whatever it may be to others. Few or no valid objections can be raised against the study of Greek in itself, and all objections to it are made simply against its being an essential for admission to college. The following are some of these:

1. It is in a majority of cases studied merely in order to pass the entrance examinations, and it is therefore an artificial and for such cases almost useless barrier. Tom Brown of Rugby, who was a typical English boy of the upper middle class, says, "I went to school to get, among other things, enough Latin and Greek to take me through Oxford respectably"; and Tom's father says of him: "I do not send him to school mainly to make him a good scholar. Neither his mother nor I care a straw for the digamma or the Greek particles. If he will only turn out a brave, truth-telling Englishman and a gentleman, that's all I want." Mr. Taine says, "Remarkable words these, and well summarizing the ordinary sentiments of an English" (and he might have added of an American) "father and child."

2. There seems to be no necessity for both Greek and Latin where one will answer every purpose, except where extreme verbal subtlety is required. As a means of inculcating clear and exact views on the philosophy of language Latin is nearly the equal of Greek, and there seems to be no need of both except in

special cases for special purposes; and as between Latin and Greek the least deserving should be dropped. Latin is the mother tongue of so many modern European languages that it has its proper place antecedent to those languages.

3. Making Greek a *sine qua non* has debarred many from entering college who, through inaptitude or inability to procure good teaching, have been unable to pass their entrance examinations in that subject.

4. The time required for Greek has acted as a prohibition on many other studies.

5. Greek being a difficult language, not enough of it is learned to be of much practical service to the student. Huxley says: "It is only a very strong man who can appreciate the charms of a landscape as he is toiling up a very steep hill along a very bad road. The ordinary schoolboy is peculiarly in this case. He finds Parnassus uncommonly steep, and there is no chance of his having much time or inclination to look about him till he gets to the top, and nine times out of ten he never gets to the top." As to the disciplinary drill in Greek, it is by no means certain that it possesses any advantages over many other studies pursued with as much care and hard work.

Says Grant Allen: "Do you think that a man can not learn just as much about the Athens of Pericles from the Elgin marbles as from a classical dictionary or a dog-eared Thucydides? Do you suppose that to have worked up the first six Iliads with a Liddell and Scott brings you in the end very much nearer the heart and soul of the primitive Achæans than to have studied with loving care the vases in the British Museum, or even to have followed with a sculptor's eye the exquisite imaginings of divine John Flaxman? Do you really suppose there is no understanding the many-sided, essentially artistic Greek idiosyncrasy except through the medium of the twenty-four written signs from alpha to omega?"

The old-fashioned classical education is an excellent and possibly necessary preparation for the legal, clerical, and pedagogic professions. It furnishes a capital training in words; it does not reach the facts behind the words; it is only plowing over again the old ground; it leaves each generation just where its predecessor was. It does not furnish either the methods or the material for originality. In the whole domain of science the classics afford a convenient terminology. That they give any useful fundamental preparatory training can not be demonstrated, and their study with this end in view is time wasted.

Greek history, mythology, philosophy, and poetry all together have less influence upon the civilization of to-day, less effect upon the prosperity, happiness, and general welfare of mankind than

the discoveries and inventions of a few modern scientific investigators. The world to-day is looking more to the future than to the past, and its great and successful men are those who know the laws which govern men and things and obey them. The direct loss to the silk industries of France in a few years was two hundred and fifty million dollars, and would have increased had not Pasteur studied the nature of the minute organism which caused the trouble, and found a means of relieving the silkworm of its presence. Had the antiseptic treatment of wounds been known thirty years ago, at least one hundred thousand lives might have been saved during the war of the rebellion. Nature punishes ignorance as sharply as willful disobedience. Incapacity and crime receive the same punishment. Certainly he who knows her laws and can add to our rapidly increasing amount of knowledge of the mysterious ways in which Nature works, is as liberally educated a person as the pedant who has had his memory trained by years of classical study.

In general, I object to that complete begging of the question which assumes that an education to be called liberal must be obtained by a course of studies comprised within any hard-and-fast lines. Recognizing the demand for a more extended and broader curriculum, the colleges have enlarged their courses, and some of them have recently changed their requirements for admission. This change must have come sooner or later. I wish to show that this change was a wise one, and also to make this suggestion, that other colleges, in addition to the privilege given the candidate of offering either Greek or a substitute, should follow the example of the few who have established an elementary course in Greek for undergraduates.

There is no substantial reason why the secondary schools should teach the elements of all the studies pursued in the colleges, and that has never been attempted or suggested for all the college courses. The colleges have always offered elementary courses in some subjects, and one course more or less would not materially affect the grade of the college. Why not offer an elementary course in Greek as well as in Hebrew or Sanskrit or modern languages? The colleges themselves complain that they are now forced to give elementary instruction in English and no instruction in several important European languages.

This would enable those who are uncertain as to their future to defer making their decision until later in life, when, if they chose to select Greek, they could bring to the study more mature judgment and the advantage of training in other subjects, and for such students Greek would no longer be a school study, but a learned study worthy of the college. Also, students who came from schools where Greek is not taught would be debarred neither

from entering college nor from pursuing that study. Since the extension of the elective system at Harvard neither Greek nor Latin studies are pursued by so large a proportion of the students as formerly, and yet a greater proficiency in classics is obtained. By this plan the graduates of our best English high schools could postpone until after graduation the choice of a career. They would then be in a fair condition to make a proper estimate of their ability, their special capacities and leanings, and their probable fitness for a commercial or a professional life.

It has been said that the recent changes in the requirements for admission to college have operated only for the benefit of inferior scholars who would not otherwise have been able to enter college. If we admit for a moment the truth of this statement, the change has some merits even on these grounds. So-called dunces are often only so many visible evidences of an imperfect and too narrow educational system. They are the results of attempting to fill square holes with round pegs, to mold and develop the manifold and diverse characteristics of human nature of both sexes by the same method and with the same appliances, in conformity with a prearranged, harmonious, and symmetrical system, just as blocks of wood are run through a machine. Many dunces at school often become distinguished in social, business, and political life, and, even in school, show ability in subjects congenial to them. Conscious of their skill in art, in music, or of their ability to do many things outside the routine of school duties better than the ordinary not specially gifted pedagogue, they feel justified from their point of view in believing that, as between themselves and their instructor, if there really be a dunce, the question is certainly debatable as to who best answers the description.

But the youth who enters college without Greek is by no means inferior in mental equipment to him who enters under the old system. From what I have seen of both methods I should advise plodding mediocrity to stick to the old lines. Hard work and good teaching have always enabled this class of pupils to pass the entrance examinations, and even sometimes to distinguish themselves. But distinction in science and mathematics is only obtained by industry plus something very closely allied to genius. In fact, at Harvard it seems to me that the new method has been handicapped by requiring too much in mathematics. Boys in secondary schools can learn and assimilate their elementary algebra, their geometry, plane, solid, and analytic, and their trigonometry, but they are not mature enough to undertake the study of advanced algebra.

The present scheme of requirements for admission to Harvard College was adopted in 1886. Since that time one hundred and forty-eight persons have entered Harvard without Greek. Thirty-

five of these have graduated, seventeen of them with honors, two receiving the A. B. and the A. M. degrees simultaneously. Of the ninety-one men who have not graduated, but have been in college long enough to make a record, a little more than half have a record above "C." President Eliot says in his annual report, "This record is a very creditable one, and shows conclusively that the persons who have thus far entered college without Greek are abundantly able to profit by their college life and to win a standing, which is, on the average, above that of those who entered with Greek."

At the time I made inquiries (one year ago) there were in Harvard University forty-eight graduates of the Boston English High School, divided as follows: undergraduates, thirty; graduate students, two; special students, six; scientific school, one; medical school, eight; law school, one. Seven graduates of the Boston English High School took their degrees at Harvard the preceding June (1891). Some idea of the rank of these seven may be obtained from the fact that they received the fourth, sixth, eleventh, thirteenth, fifteenth, and twenty-first scholarships. The seventh did not take a scholarship, as he did not need it, but he received honorable mention in natural history, and was assigned a commencement part. Of the other six, three graduated *magna cum laude* and two *cum laude*. Eight English High graduates received their diplomas at Harvard last June. Of these, one received the degree *summa cum laude*, three *magna cum laude*, two *cum laude*, and two without distinction. One of these, Lovett, led his class, was editor in chief of the Harvard Monthly, was the class-day poet, and was the best-known literary man in college. He is at present instructor in English at Harvard. Under date of September 26, 1892, President Eliot wrote me the following letter:

"HARVARD UNIVERSITY, CAMBRIDGE, *September 26, 1892.*

"MY DEAR SIR: The standing in college of the young men who have entered Harvard College from the English High School of Boston without Greek has been remarkably high. Speaking from my general knowledge of the college standing of boys from different schools, I should say that the standing of these high-school graduates has been, on the average, higher than the average standing of the graduates of any other school in the country. I have not yet made an actual comparison with figures; but I propose to do so, and to state the result in my next annual report. I suppose, however, that it would be just to state that the boys who have come from the English High School to Harvard College are picked boys; they do not represent the average of the school. I had some conversation with Mr. Waterhouse on this subject last July at Saratoga, and I wrote him a note giving the standing

of a certain number of graduates of the English High School at graduation at Harvard College. This was not a comparative statement; but any schoolmaster who is in the habit of sending pupils to Harvard College would know at sight that it was a very remarkable exhibit. Very truly yours,

(Signed) "CHARLES W. ELIOT.

"MR. JOHN F. CASEY."

During the year immediately preceding the time when I made my inquiry, in the class of '92, two English High boys were the only ones who received "A" in all their examinations in their regular work of the year. During the same year, in the class of '93, an English High graduate and a young man from Chicago were the only ones to receive "A" in all their examinations in their regular work of the year, and at the same time two English High boys outranked all others in college in English composition. During that year, of seven honors in mathematics given to all the classes, three were taken by graduates of the English High School. Of three theses selected by President Eliot as especially meritorious, two were written by boys from our school.

As might be expected, the subjects in which English High School graduates receive distinction are different from those in which classical school graduates would seek honors. The subjects in which our boys have obtained distinction are English, French, history, political economy, mathematics, natural history, chemistry, botany, and meteorology. S. M. Ballou, in his special work in meteorology, wrote an article opposing the cold-wave theory held by the Weather Bureau at Washington. This essay was translated and published in Europe, and Ballou received quite flattering letters in regard to it from eminent scientists—one especially from Mr. Woeckoff, head of the Russian Meteorological Department, in which he said that Ballou's article completely disproved the theory held by the authorities in this country. Young Ballou afterward met Prof. Russell, head of the Meteorological Department at Washington, and, having previously sent in his card, when ushered into Prof. Russell's presence, was greeted with, "I suppose you are Mr. Ballou's son." He failed to recognize in the stripling a scientific opponent. In English "B" course, which all sophomores are obliged to take, in 1888 Parker was one of four to receive "A"; in 1889 Lovett was one of ten; and in 1890 Ballou was one of three.

Among the list of instructors I find in the catalogue of Harvard College the names of four graduates of the English High School. Two English High School graduates, while undergraduates in Harvard, have been one an assistant instructor in botany and one in the fine arts. That reminds me that drawing, once

considered rather as an accomplishment than as having much practical use or educational value, is one of the studies which in many classical schools Greek has crowded to the wall.

I wish to add just a word in regard to the statement in President Eliot's letter that our boys were picked boys. In one sense they are and in another they are far from it. They have undoubtedly been above the average of the school; so are the boys from any secondary school, because at most schools the poor scholars are dropped and made to repeat and refused promotion till they have come up to a high standard. We have practically nothing of this. After graduation such boys as choose return for another year's study. During this year they are allowed within certain limits to choose their course of study, and at the end of the year they are prepared to enter the medical, law, or undergraduate department of Harvard University. One of our boys who went directly from this class to the Law School of Boston University graduated there last June *summa cum laude* at the head of his class. Most of our graduates go directly into business or to the Institute of Technology, so that we have to take the small percentage who return as they come and make the best of them. Thus they do not represent what is understood by picked boys—that is, a few of the best selected. Neither do they represent by any means in point of numbers or ability what might be sent to represent the school could the teachers exercise the right of selection from the graduating class.

I heard Mr. Bradbury, of the Cambridge Latin School, a year ago say that he had asked permission of Mr. Hill, of the Cambridge English High School, to talk to the pupils of the English High in the hope of inducing some of them to change their course and join the Latin School. It seemed to me that there was a principle involved behind this request. Boys ought to hear both sides of the question, and doubtless there are many boys in the High School who would be better off in the Latin School. And this carries with it the truth of the converse also, that there are boys in the Latin School who would be more in accord with their surroundings were they to change. Were Mr. Bradbury to obtain the required permission of Mr. Hill and also grant Mr. Hill the same privilege, some of the pupils and both schools would be benefited by the change. And were both head masters to hold out the same inducements to the pupils—viz., successful preparation for Harvard—I do not think the High School would in the end be the loser in point of numbers.

It seems to me the duty of a teacher to advise a change when he finds a pupil out of step with his class and manifestly unsuited for the course he is trying to pursue. It may be that the ideal preparatory school is one which under one head combines both

courses; then, as occasion required, pupils could be readily transferred from one course to the other; and even the senior who found his Greek too much for him could drop it and take up the alternatives of science and mathematics, pursuing more than one branch of these at the same time and reciting with more than one class if necessary. The plan is perfectly feasible, just as at Harvard we find members of different classes taking the same courses together. In the English High School we have members of the advanced class studying several branches of mathematics at once, and reciting with different classes. There is no difficulty or trouble about it. The member of the advanced class who wishes to review a certain study simply finds a class which is reciting in that study at an hour when he is disengaged and puts in an appearance to recite with this class. The only objection that I see to this would arise from the conservatism of professional educators as being inconsistent with custom and tradition. The tendency has been to separate the courses rather than unite them, but the conditions have always been quite different.

I have made special reference to Harvard College rather than to any other, because the new scheme of requirements for admission has been tried there sufficiently long to observe how it works, and these results have been made public. Boys who have succeeded at Harvard under the new regulations would have been equally successful at any other college under the same conditions. I have also cited as special examples graduates of the Boston English High School, because this school has probably sent more boys to college under the new system than any other school, and also because I have had an opportunity, through acquaintance with these young men, of knowing how they have succeeded and what they themselves have thought about their ability to get the most possible benefit from their college course.

The English High School of Boston is not a fitting school; its original design was that it should be a finishing school, and this plan has never been changed. Its course of studies covers a period of three years, and is the usual high-school course. To this is added a post-graduate course of one year, during which the student has great freedom in his choice of studies. The three-years' course is well arranged to meet the requirements of those who have no definite intention of pursuing their studies further, and the fourth year meets the demand of those who desire to do special work. A very few of the graduates of this school from choice studied Greek under a tutor during their advanced year in school, and a few more from necessity did the same thing, as they found the alternatives for Greek too difficult for them. This Greek was in most of these cases "crammed" for the special purpose of passing the entrance examinations,

and was of little use and had but little effect upon their subsequent success.

If boys who learn just enough Greek to pass the entrance examinations do not pursue that study in college and are successful in the courses which they pursue, it would seem to imply that they were prepared to take up those studies without having been examined in Greek, and that Greek was for them an unnecessary requirement, which might have been dispensed with or for which any other study requiring as much time and training might well have been substituted. A slight reduction in the alternatives for Greek would benefit English high schools, and make them legitimate preparatory schools on an equal footing with the classical schools, when both kinds of schools would be benefited by friendly rivalry, and pupils would gain by having two good, equally easy roads open to the college gates. The modern requirements for admission to college seem to have been successful thus far, and as professional instructors we ought to give so promising a plan our encouragement and wait for time to disclose by the numbers who enter under this plan and by their success whether there is a real demand for anything better than the old method, and whether that demand is a reasonable one.

ALCOHOL AND HAPPINESS.*

By Dr. JUSTUS GAULE,
OF THE UNIVERSITY OF ZURICH.

NOT as an ascetic, Dr. Gaule assures his hearers, anxious to debar them from a pleasure, but from their own standpoint, as friend with friends, all interested in increasing the sum of happiness, he wishes to discuss the proposed question. First, where do all the life activities come from? They are, as it were, latent in the body substance, the expression in some form or other of impressions received from without. Every act, of course, destroys substance, which must be replaced. Material taken from outside does this work of rebuilding, and it is of two sorts—one, which is enough like body substance to be readily changed into it and express the same activities; the other, so unlike that if it once finds way into the body in such form as to express its own latent power, it injures or destroys—is poison.

Alcohol belongs to the second class. That it injures can be readily seen in the liver, kidneys, and stomach of a drunkard, and

* Synopsis of a lecture given in Berne, the second in a series for the advancement of temperance in Switzerland.

also in more delicate changes of the elements revealed by a microscope, where the quantity taken has been even a small one. A physiological examination proves always beyond doubt that, where any appreciable quantity of alcohol has been taken, there are changes in the body substance, not always indeed wholly proportionate to the quantity taken, because the living elements have always more or less power to resist and overcome.

But I am not to deal with dangers and consequences from the use of alcohol, but with the problem of possible pleasure in existence without it. Let us see what pleasure does come from its use. While the influence of alcohol on the elements of the body is so evident and important, it is yet only as that influence touches the nerves that we are conscious of it. This becomes real to us in two ways: first, through the senses of taste and smell, as it touches the outward body; and, secondly, when it has entered into the blood and begins its chemical working in the nerve centers. How far shall we count these influences pleasurable? We are wont to count them one, but in a physiological sense they are very different, resulting from the action of very different parts of the drink taken. Wine, for instance, is made up of six elements, five of which give the taste, the sixth the fragrance of the wine. One of the five is alcohol, the only one which can not be enjoyed alone, and is never taken alone except by the man whose sense of taste has been utterly destroyed. We are not now situated as were the ancients—"*der gute Noah*," for instance—nor even as the men of the last generation, who had discovered so little of the earth's power to produce pleasure-giving substances that they were naturally delighted with and disposed to make the most of the new discovery of wine. We can take the elements of wine which do please our taste and make a better drink without alcohol. It needs only that a sufficient number of men resolve upon such a course.

But the effect of wine upon the brain and other nerve centers is that of the alcohol alone. To understand it physiologically one must remember the ordinary action of the nerves. An impression from without meets us, the nerves carry it to the nerve center, and a movement or other expression results. The movement does not, however, always accompany the sensation directly. In reading, for instance, one may indefinitely postpone any expression of received impressions; and then a single action may express a number of stored-up impressions, or again one impression may call forth a number of movements. Man has learned to in some sense measure the relation of movement to sensation—as to rapidity of movement, and as to the relative strength of the two. It is found, first, that the sharpness and certainty of sensations are modified by even small doses of alcohol, completely deadened or

destroyed by large quantities. Secondly, as to the expression of sensation in motion, small doses of alcohol increase the quickness of that expression; large doses make it slower and more slow, until at last there is no expression. Thirdly, as to the movements themselves, small doses make them more rapid, but less sure of attaining the end sought; large doses tend to make movements impossible. And popular experience bears witness to the truth of these three statements, only the masses can not understand how the rapidity with which action follows impression and rapidity of action itself are increased by small doses, but decreased by larger quantities; and the friends of alcohol have claimed that the difference between small and large doses is real, not of degree, and really distinguishes the moderation of the wise man from the madness of the foolish. But science has proved that this contradiction is only apparent. The same increased rapidity of expression of a sensation is noticed when the brain is stupefied, and the greatest rapidity results when the brain is entirely separated from the other centers. Reflex action is more sudden and more rapid than brain action. So the influence of alcohol is exactly as if the brain were cut away. The man no longer stops to consider the whole situation, to make use of impressions of former experiences stored away in his brain, or weigh present obligations, and the sly saloon-keeper well understands this. The man who would engage another in a brawl or cajole a secret from him knows well how alcohol dethrones reason and loosens the tongue. And as more and more is taken, the stupefying influence reaches lower and lower, until at last even reflex action is imperfect and slow.

If this then is the influence, where is the pleasure in it? It is not my object, however, to depict the dangers and consequences from such disturbance of brain functions, but to ask only in what then consists the pleasure which alcohol brings us? The fact that so many men seek this condition, even passionately seek and value and prefer it to others, must have deep psychological ground. I will only say in passing that men differ as to the particular time of richest delight, some choosing the very beginning, others the time when sleepiness and forgetfulness have come, still others the perfectly senseless condition; but the influence of alcohol is still the same, sometimes on a smaller, sometimes on a larger portion of the nervous system. How does it increase the feeling of happiness? The body uses its powers in resisting the outside forces which act upon it. Normally, there is a balance between body and environment. If environment prevails we are discouraged; if we are able to prevail, our spirits rise and our happiness grows. And it is not for the moment only, but we compare the accumulated impressions of the powers out-

side of us with the powers which our brains develop, and are happy or unhappy according as we feel our superiority or otherwise. Just how much does alcohol interfere in this balance of powers? It clearly can not lessen the power of outside influences which harm us; it can as clearly not increase our own powers in so far as they enter into this conflict with the outside world—it rather makes us less skillful and able. What can it do, then? It can deceive us. It dulls our appreciation of powers outside of us until they seem so much smaller that we are sure we can conquer them, and so we gain a feeling of satisfaction. Nine tenths of those who take strong drink seek this feeling in alcohol. This is their "refreshing" at eventide, their "rest from the day's cares," their forgetfulness of sorrows; but it rests upon a deceit, and at the least trial falls into ruin. He who to-day forgets is not any stronger to-morrow, and so is constantly tempted to a new appeal to his false friend until his senses are so dulled that every duty is forgotten. His holiest interests are but shadows and mist before his eyes, and he knows nothing more but thirst for the deceitful drink. Even the defenders of alcohol at last call a halt; but they have forgotten that the first steps are much more easily undone than the later ones, when the brain has in a measure lost its power to control. They do not forget through malice, but because they have not rightly understood the physiological effect of alcohol.

And the poor drinkers say: "There is so much misery in the world, and we must have now and then a care-free hour; therefore we drink. What will you give us in place of drink?" Is the argument true? Is the future of mankind really so hopeless, and does life offer nothing to the man who refuses alcohol instead of the forgetfulness which alcohol brings? I believe that in this respect the attitude of men toward this problem has very much changed. Has not the newly awakened appreciation of Nature in this century revealed a new source of joy which our forefathers did not know? Who ever could have known formerly that a glimpse of the Alps or the raging sea could give pleasure which really makes strong and furnishes recompense for trouble and trials? Our new insight into the secrets of Nature, the general dissemination of art so that even the masses may enjoy its works, these are worth more to alleviate care than anything known of old. But it comes so slowly, some say. It takes the masses so long to acquire the power to appreciate these things. But why? Because they spend their leisure hours in seeking the stupor and forgetfulness which alcohol brings, and so have no time to discover beauty anywhere; also because so many have dulled their senses until they have no power to appreciate, and because alcohol has really made the sum of misery larger. That this is true is conclusively proved in communities where alcohol is not used

at all. In Massachusetts, for instance, the most enlightened State of North America, where the question has been discussed *pro* and *con*, and the friends of alcohol have been worsted, the condition of the working class proves my statement. On a visit there I went through one of the cloth factories and was surprised when the foreman told me a certain workman wished to talk with me because he had learned I knew about microscopes. He wished to know what microscope was most in favor in Germany. I described a good one of moderate price, twenty dollars; but he said he had one of that sort and wished now a better one. On questioning him I found he really had knowledge about bacteria, for the study of which he wished his instrument; that he was president of a club of workmen who spent their leisure hours in this study. When I then looked at the homes of these workmen, with their pretty, well-tended gardens and blooming, well-dressed children, I felt clearly the different atmosphere where the father spends his spare time and money not for alcohol, but for the beautifying of his home. And can this life be less enjoyable than ours?

In Mr. Bryce's American Commonwealth he has devoted one chapter to the consideration of the pleasant character of American life, in which he calls attention to the general air of hopefulness which prevails among American people and extends also to all foreigners who visit them, through which, moreover, difficulties are lightly overcome, losses and injuries good-naturedly endured. One misses this characteristic painfully among us when one has once experienced it; it is like a new melody in the great concert of life. . . . And what says this melody? I understood it first as I saw this hopeful spirit, and I said to myself, Must mankind then be always miserable? Must they be always helpless against Nature's forces? Can they not conquer these forces, make them subservient, if they use intelligence to understand them instead of stupefying themselves? Must they pine away for lack of pleasure in a world which is so beautiful that it charms us if we lift but the corner of the veil which hides its secrets? This it is which makes me consider life without alcohol more beautiful than the other, and that is the transformation in the feeling of mankind which I await with their development.

Nothing retards this development except that we are bound by the customs of the middle ages. The conditions of the middle ages have vanished, but the habit of stupor still remains, as if, in place of the serfs and lords of old, a new man had not come who can use his manly powers. See what this inheritance of inactivity costs us. Statistics of last year show that in Switzerland every tenth man who died, died directly or indirectly from drink; that of men between forty and fifty-nine years old every

sixth was killed by alcohol. You have learned how our hospitals for the insane are filled and how men are led to violence from Dr. Speyr's lecture, and you recall scenes of coarseness you have yourselves seen as the result of alcohol. You will see that a chain of coarseness is drawn about our whole life, which binds us fast on a plane of barbarity and wretchedness. Follow this chain even to yourselves. It is wound about you. . . . That here one dies of delirium tremens, there one loses his senses through alcohol, there a deed of violence is done, here a brutality perpetrated —these are all manifestations of a single great phenomenon, the bondage of mankind to a plane of rudeness in which they deaden and make useless the most precious instrument which is given them for their development; and you are sharers in the guilt so long as you do not break this chain, so long as you do not have courage to adjust your life-compass with reference to the future instead of the past.

This is the joy of the one who does not drink—the feeling of freedom from responsibility for misery, the joy of hope for the future of mankind, the increased sensitiveness to the beauty of the world; and on us, the chosen people, rest the hopes of the world for the future. We must be leaders.

UNSOLVED PROBLEMS OF SCIENCE.*

By the Most Hon. the MARQUIS OF SALISBURY, K. G., D. C. L., F. R. S., CHANCELLOR OF THE UNIVERSITY OF OXFORD.

MY functions are of a more complicated character than usually is assigned to the occupants of this chair. As Chancellor of the University it is my duty to tender to the British Association a hearty welcome, which it is my duty as President of the Association to accept. As President of the Association I convey, most unworthily, the voice of English science, as many worthy and illustrious presidents have done before me; but in representing the university I represent far more fittingly the learners who are longing to hear the lessons which the first teachers of English science have come as visitors to teach. I am bound to express on behalf of the university our sense of the good feeling toward that body which is the motive of this unusual arrangement; but, as far as I am personally concerned, it is attended with some embarrassing results. In presence of the high priests of science I am only a layman, and all the skill of

* Inaugural Address of the President of the British Association for the Advancement of Science.

all the chemists the association contains will not transmute a layman into any more precious kind of metal. Yet it is my hard destiny to have to address on scientific matters probably the most competent scientific audience in the world. If a country gentleman, who was also a colonel of volunteers, were by any mental aberration on the part of the commander-in-chief to be appointed to review an army corps at Aldershot, all military men would doubtless feel a deep compassion for his inevitable fate. I bespeak some spark of that divine emotion when I am attempting to discharge under similar conditions a scarcely less hopeless duty. At least, however, I have the consolation of feeling that I am free from some of the anxieties which have fallen to those who have preceded me as presidents in this city. The relations of the association and the university are those of entire sympathy and good will, as becomes common workers in the sacred cause of diffusing enlightenment and knowledge. But we must admit that it was not always so. A curious record of a very different state of feeling came to light last year in the interesting biography of Dr. Pusey, which is the posthumous work of Canon Liddon. In it is related the first visit of the association to Oxford in 1832. Mr. Keble, at that time a leader of university thought, writes indignantly to his friend to complain that the honorary degree of D. C. L. had been bestowed upon some of the most distinguished members of the association. "The Oxford doctors," he says, "have truckled sadly to the spirit of the times in receiving the hodge-podge of philosophers as they did." It is amusing, at this distance of time, to note the names of the hodge-podge of philosophers whose academical distinction so sorely vexed Mr. Keble's gentle spirit. They were Brown, Brewster, Faraday, and Dalton. When we recollect the lovable and serene character of Keble's nature, and that he was at that particular date probably the man in the university who had the greatest power over other men's minds, we can measure the distance we have traversed since that time, and the rapidity with which the converging paths of these two intellectual luminaries, the university and the association, have approximated to each other. This sally of Mr. Keble's was no passing or accidental caprice. It represented a deep-seated sentiment in this place of learning, which had its origin in historic causes, and which has only died out in our time. One potent cause of it was that both bodies were teachers of science, but did not then in any degree attach the same meaning to that word. Science with the university for many generations bore a signification different from that which belongs to it in this assembly. It represented the knowledge which alone in the middle ages was thought worthy of the name of science. It was the knowledge gained not by external observation, but by mere reflection. The

student's microscope was turned inward upon the recesses of his own brain; and when the supply of facts and realities failed, as it very speedily did, the scientific imagination was not wanting to furnish to successive generations an interminable series of conflicting speculations. *That* science—science in our academical sense—had its day of rapid growth, of boundless aspiration, of enthusiastic votaries. It fascinated the rising intellect of the time, and it is said—people were not particular about figures in those days—that its attractions were at one time potent enough to gather round the university thirty thousand students, who for the sake of learning its teaching were willing to endure a life of the severest hardship. Such a state of feeling is now an archæological curiosity. The revolt against Aristotle is now some three centuries old. But the mental sciences which were supposed to rest upon his writings have retained some of their ascendency even till this day, and have only slowly and jealously admitted the rivalry of the growing sciences of observation. The subject is interesting to us, as this undecided state of feeling colored the experiences of this association at its last Oxford visit, nearly a generation later, in 1860. The warmth of the encounters which then took place have left a vivid impression on the minds of those who are old enough to have witnessed them. That much energy was on that occasion converted into heat may, I think, be inferred from the mutual distance which the two bodies have since maintained. Whereas the visit of 1832 was succeeded by another visit in fifteen years, and the visit of 1847 was succeeded by another visit in thirteen years, the year 1860 was followed by a long and dreary interval of separation, which has only now, after four-and-thirty years, been terminated. It has required the lapse of a generation to draw the curtain of oblivion over those animated scenes. It was popularly supposed that deep divergences upon questions of religion were the motive force of those high controversies. To some extent that impression was correct. But men do not always discern the motives which are really urging them, and I suspect that in many cases religious apprehensions only masked the resentment of the older learning at the appearance and claims of its younger rival. In any case, there is something worthy of note, and something that conveys encouragement, in the difference of the feeling which prevails now and the feeling that was indicated then. Few men are now influenced by the strange idea that questions of religious belief depend on the issues of physical research. Few men, whatever their creed, would now seek their geology in the books of their religion, or, on the other hand, would fancy that the laboratory or the microscope could help them to penetrate the mysteries which hang over the nature and the destiny of the soul of man. And the old learning no

longer contests the share in education which is claimed by the new, or is blind to the supreme influence which natural knowledge is exercising in molding the human mind.

A study of the addresses of my learned predecessors in this office shows me that the main duty which it falls to a president to perform in his introductory address is to remind you of the salient points in the annals of science since last the association visited the town in which he is speaking. Most of them have been able to lay before you in all its interesting detail the history of the particular science of which each one of them was the eminent representative. If I were to make any such attempt I should only be telling you with very inadequate knowledge a story which is from time to time told you, as well as it can be told, by men who are competent to deal with it. It will be more suitable to my capacity if I devote the few observations I have to make to a survey not of our science but of our ignorance. We live in a small, bright oasis of knowledge, surrounded on all sides by a vast unexplored region of impenetrable mystery. From age to age the strenuous labor of successive generations wins a small strip from the desert and pushes forward the boundary of knowledge. Of such triumphs we are justly proud. It is a less attractive task—but yet it has its fascination as well as its uses—to turn our eyes to the undiscovered country which still remains to be won, to some of the stupendous problems of natural study which still defy our investigation. Instead, therefore, of recounting to you what has been done, or trying to forecast the discoveries of the future, I would rather draw your attention to the condition in which we stand toward three or four of the most important physical questions which it has been the effort of the last century to solve.

Of the scientific enigmas which still, at the end of the nineteenth century, defy solution, the nature and origin of what are called the elements is the most notable. It is not, perhaps, easy to give a precise logical reason for the feeling that the existence of our sixty-five elements is a strange anomaly and conceals some much simpler state of facts; but the conviction is irresistible. We can not conceive, on any possible doctrine of cosmogony, how these sixty-five elements came into existence. A third of them form the substance of this planet. Another third are useful, but somewhat rare. The remaining third are curiosities scattered haphazard, but very scantily, over the globe, with no other apparent function but to provide occupation for the collector and the chemist. Some of them are so like each other that only a chemist can tell them apart; others differ immeasurably from each other in every conceivable particular. In cohesion, in weight, in conductivity, in melting point, in chemical proclivities

they vary in every degree. They seem to have as much relation to each other as the pebbles on a sea beach or the contents of an ancient lumber room. Whether you believe that Creation was the work of design or of inconscient law, it is equally difficult to imagine how this random collection of dissimilar materials came together. Many have been the attempts to solve this enigma, but up till now they have left it more impenetrable than before. A conviction that here was something to discover lay beneath the persistent belief in the possibility of the transmutation of other metals into gold, which brought the alchemy of the middle ages into being. When the immortal discovery of Dalton established that the atoms of each of these elements have a special weight of their own, and that consequently they combine in fixed ponderable proportions from which they never depart, it renewed the hope that some common origin of the elements was in sight. The theory was advanced that all these weights were multiples of the weight of hydrogen—in other words, that each elementary atom was only a greater or a smaller number of hydrogen atoms compacted by some strange machinery into one. The most elaborate analyses, conducted by chemists of the highest eminence—conspicuously by the illustrious Stas—were directed to the question whether there was any trace in fact of the theoretic idea that the atoms of each element consist of so many atoms or even of so many half-atoms of hydrogen. But the reply of the laboratories has always been clear and certain—that there is not in the facts the faintest foundation for such a theory.

Then came the discovery of the spectrum analysis, and men thought that with an instrument of such inconceivable delicacy we should at last find out something as to the nature of the atom. The result has been wholly disappointing. Spectrum analysis in the hands of Dr. Huggins and Mr. Lockyer and others has taught us things of which the world little expected to be told. We have been enabled to measure the speed with which clouds of blazing hydrogen course across the surface of the sun; we have learned the pace—the fabulous pace—at which the most familiar stars have been for ages approaching to or receding from our planet, without apparently affecting the proportions of the patterns which, as far as historical record goes back, they have always delineated on the evening sky. We have received some information about the elementary atoms themselves. We have learned that each sort of atom, when heated, strikes upon the ether a vibration, or set of vibrations, whose rate is all its own; and that no one atom or combination of atoms, in producing its own spectrum, encroaches even to the extent of a single line upon the spectrum that is peculiar to its neighbor. We have learned that the elements which exist in the stars, and especially in the sun, are

mainly those with which we are familiar upon earth. There are a few lines in excess to which we can give no terrestrial name; and there are some still more puzzling gaps in our list. It is a great aggravation of the mystery which besets the question of the elements that, among the lines which are absent from the spectrum of the sun, those of nitrogen and oxygen stand first. Oxygen constitutes the largest portion of the solid and liquid substance of our planet, so far as we know it; and nitrogen is very far the predominant constituent of our atmosphere. If the earth is a detached bit whirled off the mass of the sun, as cosmogonists love to tell us, how comes it that in leaving the sun we cleaned him out so completely of his nitrogen and oxygen that not a trace of these gases remains behind to be discovered even by the sensitive vision of the spectroscope?

All these things the discovery of the spectrum analysis has added to our knowledge; but it has left us as ignorant as ever as to the nature of the capricious differences which separate the atoms from each other, or the cause to which those differences are due.

In the last few years the same enigma has been approached from another point of view by Prof. Mendeléeff. The periodic law which he has discovered reflects on him all the honor that can be earned by ingenious, laborious, and successful research. He has shown that this perplexing list of elements can be divided into families of about seven, speaking very roughly; that those families all resemble each other in this, that as to weight, volume, heat, and laws of combination, the members of each family are ranked among themselves in obedience to the same rule. Each family differs from the others, but each internally is constructed upon the same plan. It was a strange discovery—strangest of all in its manifest defects; for in the plan of his families there were blanks left—places not filled up because the properly constituted elements required according to his theory had not been found to fill them. For a moment their absence seemed a weakness in the professor's idea, and gave an arbitrary aspect to his scheme. But the weakness was turned into strength when, to the astonishment of the scientific world, three of the elements which were missing made their appearance in answer to his call. He had described beforehand the qualities they ought to have; and gallium, germanium, and scandium, when they were discovered shortly after the publication of his theory, were found to be duly clothed with the qualities he required in each. This remarkable confirmation has left Mendeléeff's periodic law in an unassailable position. But it has rather thickened than dissipated the mystery which hangs over the elements. The discovery of these co-ordinate families dimly points to some identical origin, without suggesting the method of their genesis or the nature of their common par-

entage. If they were organic beings, all our difficulties would be solved by muttering the comfortable word "evolution"—one of those indefinite words from time to time vouchsafed to humanity, which have the gift of alleviating so many perplexities and masking so many gaps in our knowledge. But the families of elementary atoms do not breed; and we can not therefore ascribe their ordered difference to accidental variations perpetuated by heredity under the influence of natural selection. The rarity of iodine, and the abundance of its sister chlorine, can not be attributed to the survival of the fittest in the struggle for existence. We can not account for the minute difference which persistently distinguishes nickel from cobalt, by ascribing it to the recent inheritance by one of them of an advantageous variation from the parent stock.

The upshot is that all these successive triumphs of research, Dalton's, Kirchhoff's, Mendeléeff's, greatly as they have added to our store of knowledge, have gone but little way to solve the problem which the elementary atoms have for centuries presented to mankind. What the atom of each element is, whether it is a movement, or a thing, or a vortex, or a point having inertia, whether there is any limit to its divisibility, and, if so, how that limit is imposed, whether the long list of elements is final, or whether any of them have any common origin, all these questions remain surrounded by a darkness as profound as ever. The dream which lured the alchemists to their tedious labors, and which may be said to have called chemistry into being, has assuredly not been realized, but it has not yet been refuted. The boundary of our knowledge in this direction remains where it was many centuries ago.

The next discussion to which I should look in order to find unsolved riddles which have hitherto defied the scrutiny of science, would be the question of what is called the ether. The ether occupies a highly anomalous position in the world of science. It may be described as a half-discovered entity. I dare not use any less pedantic word than entity to designate it, for it would be a great exaggeration of our knowledge if I were to speak of it as a body or even as a substance. When, nearly a century ago, Young and Fresnel discovered that the motions of an incandescent particle were conveyed to our eyes by undulation, it followed that between our eyes and the particle there must be something to undulate. In order to furnish that something, the notion of the ether was conceived, and for more than two generations the main, if not the only, function of the word ether has been to furnish a nominative case to the verb "to undulate." Lately, our conception of this entity has received a notable extension. One of the most brilliant of the services which Prof. Maxwell has rendered

to science has been the discovery that the figure which expressed the velocity of light, also expressed the multiplier required to change the measure of static or passive electricity into that of dynamic or active electricity. The interpretation reasonably affixed to this discovery is that, as light and the electric impulse move approximately at the same rate through space, it is probable that the undulations which convey them are undulations of the same medium. And as induced electricity penetrates through everything, or nearly everything, it follows that the ether through which its undulations are propagated must pervade all space, whether empty or full, whether occupied by opaque matter or transparent matter, or by no matter at all. The attractive experiments by which the late Prof. Hertz illustrated the electric vibrations of the ether will only be alluded to by me, in order that I may express the regret deeply and generally felt that death should have terminated prematurely the scientific career which had begun with such brilliant promise and such fruitful achievements. But the mystery of the ether, though it has been made more fascinating by these discoveries, remains even more inscrutable than before. Of this all-pervading entity we know absolutely nothing except this one fact, that it can be made to undulate. Whether, outside the influence of matter on the motion of its waves, ether has any effect on matter or matter upon it, is absolutely unknown. And even its solitary function of undulating ether performs in an abnormal fashion which has caused infinite perplexity. All fluids that we know transmit any blow they have received by waves which undulate backward and forward in the path of their own advance. The ether undulates athwart the path of the wave's advance. The genius of Lord Kelvin has recently discovered what he terms a labile state of equilibrium, in which a fluid that is infinite in its extent may exist, and may undulate in this eccentric fashion without outraging the laws of mathematics. I am no mathematician, and I can not judge whether this reconciliation of the action of the ether with mechanical law is to be looked upon as a permanent solution of the question, or is only what diplomatists call a *modus vivendi*. In any case it leaves our knowledge of the ether in a very rudimentary condition. It has no known qualities except one, and that quality is in the highest degree anomalous and inscrutable. The extended conception which enables us to recognize ethereal waves in the vibrations of electricity has added infinite attraction to the study of those waves, but it carries its own difficulties with it. It is not easy to fit in the theory of electrical ether waves with the phenomena of positive and negative electricity; and as to the true significance and cause of those counteracting and complementary forces, to which we give the provi-

sional names of negative and positive, we know about as much now as Franklin knew a century and a half ago.

I have selected the elementary atoms and the ether as two instances of the obscurity that still hangs over problems which the highest scientific intellects have been investigating for several generations. A more striking but more obvious instance still is life—animal and vegetable life—the action of an unknown force on ordinary matter. What is the mysterious impulse which is able to strike across the ordinary laws of matter, and twist them for a moment from their path? Some people demur to the use of the term "vital force" to designate this impulse. In their view the existence of such a force is negatived by the fact that chemists have been able by cunning substitutions to produce artificially the peculiar compounds which in Nature are only found in organisms that are or have been living. These compounds are produced by some living organism in the performance of the ordered series of functions proper to its brief career. To counterfeit them—as has been done in numerous cases—does not enable us to do what the vital force alone can effect—to bring the organism itself into existence, and to cause it to run its appointed course of change. This is the unknown force which continues to defy not only our imitation but our scrutiny. Biology has been exceptionally active and successful during the last half century. Its triumphs have been brilliant, and they have been rich enough not only in immediate result but in the promise of future advance. Yet they give at present no hope of penetrating the great central mystery. The progress which has been made in the study of microscopic life has been very striking, whether or not the results which are at present inferred from it can be taken as conclusive. Infinitesimal bodies found upon the roots of plants have the proud office of capturing and taming for us the free nitrogen of the air, which, if we are to live at all, we must consume and assimilate, and yet which, without the help of our microscopic ally, we could not draw for any useful purpose from the ocean of nitrogen in which we live. Microscopic bodies are convicted of causing many of the worst diseases to which flesh is heir, and the guilt of many more will probably be brought home to them in due time; and they exercise a scarcely less sinister or less potent influence on our race by the plagues with which they destroy some of the most valuable fruits of husbandry, such as the potato, the mulberry, and the vine. Almost all their power resides in the capacity of propagating their kind with infinite rapidity, and up to this time science has been more skillful in describing their ravages than in devising means to hinder them. It would be ungrateful not to mention two brilliant exceptions to this criticism. The antiseptic surgery which we owe chiefly to Lister, and the

inoculation against anthrax, hydrophobia, and perhaps some other diseases, which we owe to Pasteur, must be recorded as splendid victories over the countless legions of our infinitesimal foes. Results like these are the great glory of the scientific workers of the past century. Men may, perhaps, have overrated the progress of nineteenth-century research in opening the secrets of Nature; but it is difficult to overrate the brilliant service it has rendered in ministering to the comforts and diminishing the sufferings of mankind.

If we are not able to see far into the causes and origin of life in our own day, it is not probable that we shall deal more successfully with the problem as it arose many million years ago. Yet certainly the most conspicuous event in the scientific annals of the last half century has been the publication of Mr. Darwin's work on the Origin of Species, which appeared in 1859. In some respects, in the depth of the impression which it made on scientific thought, and even on the general opinion of the world, its momentous effect can hardly be overstated. But at this distance of time it is possible to see that some of its success has been due to adventitious circumstances. It has had the chance of enlisting among its champions some of the most powerful intellects of our time, and perhaps the still happier fortune of appearing at a moment when it furnished an armory of weapons to men, who were not scientific, for use in the bitter but transitory polemics of the day. But far the largest part of its accidental advantages was to be found in the remarkable character and qualifications of its author. The equity of judgment, the simple-minded love of truth and the patient devotion to the pursuit of it through years of toil and of other conditions the most unpropitious—these things endeared to numbers of men everything that came from Charles Darwin, apart from its scientific merit or literary charm. And whatever final value may be assigned to his doctrine, nothing can ever detract from the luster shed upon it by the wealth of his knowledge and the infinite ingenuity of his resource. The intrinsic power of his theory is shown at least in this one respect, that in the department of knowledge with which it is concerned it has effected an entire revolution in the methods of research. Before his time the study of living Nature had a tendency to be merely statistical; since his time it has become predominantly historical. The consideration how any organic body came to be what it is occupies a far larger area in any inquiry now than the mere description of its actual condition; but this question was not predominant—it may almost be said to have been ignored—in the botanical and zoölogical study of sixty years ago.

Another lasting and unquestioned effect has resulted from Darwin's work. He has, as a matter of fact, disposed of the doc-

trine of the immutability of species. It has been mainly associated in recent days with the honored name of Agassiz, but with him has disappeared the last defender of it who could claim the attention of the world. Few now are found to doubt that animals separated by differences far exceeding those that distinguished what we know as species have yet descended from common ancestors. But there is much less agreement as to the extent to which this common descent can be assumed, or the process by which it has come about. Darwin himself believed that all animals were descended from "at most four or five progenitors"—adding that "there was grandeur in the view that life had been originally breathed by the Creator into a few forms or one." Some of his more devoted followers, like Prof. Haeckel, were prepared to go a step further and to contemplate a crystal as the probable ancestor of the whole fauna and flora of this planet.

To this extent the Darwinian theory has not effected the conquest of scientific opinion; and still less is there any unanimity in the acceptance of natural selection as the sole or even the main agent of whatever modifications may have led up to the existing forms of life. The deepest obscurity still hangs over the origin of the infinite variety of life. Two of the strongest objections to the Darwinian explanation appear still to retain all their force.

I think Lord Kelvin was the first to point out that the amount of time required by the advocates of the theory for working out the process they had imagined could not be conceded without assuming the existence of a totally different set of natural laws from those with which we are acquainted. His view was not only based on profound mechanical reasoning, but it was so plain that any layman could comprehend it. Setting aside arguments deduced from the resistance of the tides, which may be taken to transcend the lay understanding, his argument from the refrigeration of the earth requires little science to apprehend it. Everybody knows that hot things cool, and that according to their substance they take more or less time in cooling. It is evident from the increase of heat as we descend into the earth that the earth is cooling, and we know by experiment, within certain wide limits, the rate at which its substances, the matters of which it is constituted, are found to cool. It follows that we can approximately calculate how hot it was so many million years ago. But if at any time it was hotter at the surface by 50° Fahr. than it is now, life would then have been impossible upon the planet, and therefore we can without much difficulty fix a date before which organic life on earth can not have existed. Basing himself on these considerations, Lord Kelvin limited the period of organic life upon the earth to a hundred million years, and Prof. Tait in a still more penurious spirit cut that hundred down to ten. But on the

other side of the account stand the claims of the geologists and biologists. They have reveled in the prodigality of the ciphers which they put at the end of the earth's hypothetical life. Long cribbed and cabined within the narrow bounds of the popular chronology, they have exulted wantonly in their new freedom. They have lavished their millions of years with the open hand of a prodigal heir indemnifying himself by present extravagance for the enforced self-denial of his youth. But it can not be gainsaid that their theories require at least all this elbow-room. If we think of that vast distance over which Darwin conducts us from the jellyfish lying on the primeval beach to man as we know him now; if we reflect that the prodigious change requisite to transform one into the other is made up of a chain of generations, each advancing by a minute variation from the form of its predecessor; and if we further reflect that these successive changes are so minute that in the course of our historical period—say three thousand years—this progressive variation has not advanced by a single step perceptible to our eyes, in respect to man or the animals and plants with which man is familiar, we shall admit that for a chain of change so vast, of which the smallest link is longer than our recorded history, the biologists are making no extravagant claim when they demand at least many hundred million years for the accomplishment of the stupendous process. Of course, if the mathematicians are right, the biologists can not have what they demand. If, for the purposes of their theory, organic life must have existed on the globe more than a hundred million years ago, it must, under the temperature then prevailing, have existed in a state of vapor. The jellyfish would have been dissipated in steam long before he had had a chance of displaying the advantageous variation which was to make him the ancestor of the human race. I see, in the eloquent discourse of one of my most recent and most distinguished predecessors in this chair, Sir Archibald Geikie, that the controversy is still alive. The mathematicians sturdily adhere to their figures, and the biologists are quite sure the mathematicians must have made a mistake. I will not get myself into the line of fire by intervening in such a controversy. But until it is adjusted the laity may be excused for returning a verdict of "not proven" upon the wider issues the Darwinian school has raised.

The other objection is best stated in the words of an illustrious disciple of Darwin, who has recently honored this city by his presence—I refer to Prof. Weismann. But in referring to him, I can not but give, in passing, a feeble expression to the universal sorrow with which in this place the news was received that Weismann's distinguished antagonist, Prof. Romanes, had been taken from us in the outset and full promise of a splendid scientific career.

The gravest objection to the doctrine of natural selection was expressed by Weismann in a paper published a few months ago, not as agreeing to the objection, but as resisting it; and therefore his language may be taken as an impartial statement of the difficulty. "We accept natural selection," he says, "not because we are able to demonstrate the process in detail, not even because we can with more or less ease imagine it, but simply because we must —because it is the only possible explanation that we can conceive. We must assume natural selection to be the principle of the explanation of the metamorphoses, because all other apparent principles of explanation fail us, and it is inconceivable that there could yet be another capable of explaining the adaptation of organisms without assuming the help of a principle of design."

There is the difficulty. We can not demonstrate the process of natural selection in detail; we can not even, with more or less ease, imagine it. It is purely hypothetical. No man, so far as we know, has ever seen it at work. An accidental variation may have been perpetuated by inheritance, and in the struggle for existence the bearer of it may have replaced, by virtue of the survival of the fittest, his less improved competitors; but, as far as we know, no man or succession of men have ever observed the whole process in any single case, and certainly no man has recorded the observation. Variation by *artificial* selection, of course, we know very well; but the intervention of the cattle breeder and the pigeon fancier is the essence of artificial selection. It is effected by their action in crossing, by their skill in bringing the right mates together to produce the progeniture they want. But in natural selection who is to supply the breeder's place? Unless the crossing is properly arranged, the new breed will never come into being. What is to secure that the two individuals of opposite sexes in the primeval forest, who had been both accidentally blessed with the same advantageous variation, shall meet, and transmit by inheritance that variation to their successors? Unless this step is made good, the modification will never get a start; and yet there is nothing to insure that step, except pure chance. The law of chances takes the place of the cattle breeder and the pigeon fancier. The biologists do well to ask for an immeasurable expanse of time, if the occasional meetings of advantageously varied couples from age to age are to provide the pedigree of modifications which unite us to our ancestor the jellyfish. Of course the struggle for existence, and the survival of the fittest, would in the long run secure the predominance of the stronger breed over the weaker. But it would be of no use in setting the improved breed going. There would not be time. No possible variation which is known to our experience, in the short time that elapses in a single life between the moment of maturity and the

age of reproduction, could enable the varied individual to clear the field of all competitors, either by slaughtering or starving them out. But unless the struggle for existence took this summary and internecine character, there would be nothing but mere chance to secure that the advantageously varied bridegroom at one end of the wood should meet the bride who by a happy contingency had been advantageously varied in the same direction at the same time at the other end of the wood. It would be a mere chance if they ever knew of each other's existence—a still more unlikely chance that they should resist on both sides all temptations to a less advantageous alliance. But unless they did so, the new breed would never even begin, let alone the question of its perpetuation after it had begun. I think Prof. Weismann is justified in saying that we can not, either with more or less ease, imagine the process of natural selection.

It seems strange that a philosopher of Prof. Weismann's penetration should accept as established a hypothetical process the truth of which he admits that he can not demonstrate in detail, and the operation of which he can not even imagine. The reason that he gives seems to me instructive of the great danger scientific research is running at the present time—the acceptance of mere conjecture in the name and place of knowledge, in preference to making frankly the admission that no certain knowledge can be attained. "We accept natural selection," he says, "because we must—because it is the only possible explanation that we can conceive." As a politician, I know that argument very well. In political controversy it is sometimes said of a disputed proposal that it "holds the field," that it must be accepted because no possible alternative has been suggested. In politics there is occasionally a certain validity in the argument, for it sometimes happens that some definite course must be taken, even though no course is free from objection. But such a line of reasoning is utterly out of place in science. We are under no obligation to find a theory, if the facts will not provide a sound one. To the riddles which Nature propounds to us the profession of ignorance must constantly be our only reasonable answer. The cloud of impenetrable mystery hangs over the development and still more over the origin of life. If we strain our eyes to pierce it, with the foregone conclusion that some solution is and must be attainable, we shall only mistake for discoveries the figments of our own imagination. Prof. Weismann adds another reason for his belief in natural selection, which is certainly characteristic of the time in which we live. "It is inconceivable," he says, "that there should be another principle capable of explaining the adaptation of organisms without assuming the help of a principle of design." The whirligig of time assuredly brings its revenges.

Time was, not very long ago, when the belief in creative design was supreme. Even those who were sapping its authority were wont to pay it a formal homage, fearing to shock the public conscience by denying it. Now the revolution is so complete that a great philosopher uses it as a *reductio ad absurdum*, and prefers to believe that which can neither be demonstrated in detail nor imagined, rather than run the slightest risk of such a heresy.

I quite accept the professor's dictum that if natural selection is rejected we have no resource but to fall back on the mediate or immediate agency of a principle of design. In Oxford, at least, he will not find that argument is conclusive, nor, I believe, among scientific men in this country generally, however imposing the names of some whom he may claim for that belief. I would rather lean to the conviction that the multiplying difficulties of the mechanical theory are weakening the influence it once had acquired. I prefer to shelter myself in this matter behind the judgment of the greatest living master of natural science among us, Lord Kelvin, and to quote as my own concluding words the striking language with which he closed his address from this chair more than twenty years ago. "I have always felt," he said, "that the hypothesis of natural selection does not contain the true theory of evolution, if evolution there has been in biology. . . . I feel profoundly convinced that the argument of design has been greatly too much lost sight of in recent zoölogical speculations. Overpoweringly strong proofs of intelligent and benevolent design lie around us, and if ever perplexities, whether metaphysical or scientific, turn us away from them for a time, they come back upon us with irresistible force, showing to us through Nature the influence of a free will, and teaching us that all living things depend on one everlasting Creator and Ruler."

LAST year, Garden and Forest says, the Genesee Valley Forestry Association of Rochester, N. Y., offered prizes to the children of the public schools for gathering the cocoons of caterpillars, and had encouraging success. This year, in addition to the other prizes, a special prize of ten dollars was offered to all who would bring a larger number than was brought in 1893 by any one pupil (44,900). Sixty-five pupils gained and received this prize, and five dollars each were given to the two boys who had the largest count. Eight million, eight hundred thousand and two hundred cocoons were gathered, and the city was relieved of that number of destroyers of vegetation and nuisances.

PRIZES are offered by the *Revue Suisse de Photographie*, Geneva, for the best photograph of a falling drop of water. The drops are to be of distilled water, issuing from a tube, the internal and external diameters of which are measured, with no special conditions as to the size of the picture, but with preferences for something near the natural size. Three prizes of medals will be given and three honorable mentions.

MANUAL TRAINING.

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I.

THE editor of The Popular Science Monthly has always taken a warm interest in the question of manual training. On two occasions he has been kind enough to allow me to speak to his readers in the columns of the magazine. I have much valued these opportunities. The first article appeared in August, 1889, and was entitled The Spirit of Manual Training. It dealt with the general aspect of the subject, and more especially emphasized the ethical significance of well-performed action. The second article appeared in May, 1894, under the title of Cause and Effect in Education. It contained no direct reference to manual training. It was intended, however, to serve as an introduction to the two articles which the editor now asks me to write. It did this by illustrating the main proposition upon which manual training rests its educational claim, the very simple and undeniable proposition that we can only attain a rational education by setting in operation adequate causes. I am referring to these previous articles in order to avoid repetition. In the present paper it is my purpose to speak of the outward aspect of manual training, and in the succeeding paper, of its inner content.

It must be borne in mind at the very outset that manual training is not a complete and separate system of education, excluding other branches of human culture, and only administered during a definite period of boyhood. On the contrary, it is but one branch out of the many which make up the sum of education, and as such is applicable in every grade of school life. One must dismiss the idea that a manual training school is a "peculiar" institution which has parted company with the older avenues of culture, and has struck out in a new and somewhat erratic path of its own. It is quite possible that its early advocates held some such conception of its mission, but the view is certainly not shared by those who are trying to give manual training daily expression in the schools. A more modest conception prevails. Manual training is held to be a part of culture, not culture itself.

Curiously, manual training effected its entrance into the curriculum at both ends of the educational sequence—in the kindergarten and in the scientific departments of the universities. From the bottom and from the top it has been steadily pushing its way toward the center, until now the two frontiers are within plain sight of each other. The manual activities of the kindergarten,

the weaving, modeling, and building, are succeeded by the sloyd of the primary school, while the technical work of the universities and scientific schools is now being preceded by the systematic wood and metal work of the manual-training high schools. The unoccupied territory lies between, in the elementary schools. It is, however, not entirely unoccupied. Already the simpler forms of wood work and clay modeling are being introduced into many of these schools, and the frontiers are disappearing.

This dual start is responsible for what would otherwise be a curious conflict of *motif* in the development of the manual training idea. The kindergarten has always in view the thought of the child. Its activities have but one purpose, and that is development. The things produced have in themselves no value whatever. The whole operation is a process. Its importance is subjective. One might, I think, sum up the ideal of the kindergarten in saying that its end is the cultivation of perception, and its method is the self-activity of the child.

It is far otherwise in the technical schools of the universities. Seldom have processes called educational been so oblivious of the material upon which they work. Men are taught to analyze iron and copper ores, because these analyses are needed in the industrial world; to survey fields and farms, because of the social necessity of emphasizing the difference between *meum* and *tuum;* to file and fit and turn, because only by such operations can machines be built; and to do a hundred other things whose end is objective. The work has regard only to itself. It is needed in the great outer world of enterprise and action. The worker is a part of the productive mechanism, and is now a means. Observe the contrast. In the kindergarten, the work was the means and the worker the end.

We thus find, at the two extremes of the educational line, parallel activities but opposite motives. So long as the frontier of the intermediate schools remained between the two, there was little conflict of ideals. Different sets of people were interested in each, and, as the interests were in both cases large, they prevented a too critical examination of the distant activity to which they were opposed. Thus became possible the spectacle of a father sacrificing himself to some industrial end, working beyond the point of fatigue, exceeding the bounds of sanity, while his children in the kindergarten were engaged in activities which were purely, though unconsciously, self-regarding; and no one appears to have found the spectacle so inconsistent as to be distressing.

But when manual training moved from its extreme positions and progressed along the line toward the center, it carried its motives with it—the educational motive upward, the technical motive downward. In the secondary schools the two have met

and are in daily conflict. Sometimes this conflict of ideals is between different schools of presumably the same grade and intent. In one, manual training is followed as an educational process, and in the other as an industrial end. The outer world—if it be discriminating enough to really get at what the schools are about—sees two institutions of similar name and curriculum, and interprets the school according to the one it happens to visit. Very frequently the conflict is a civil war, having its seat in one and the same school, a part of the faculty working in one spirit and a part in the other. But most perplexing of all, one sees the conflict going on even in the same individual, the educational idea uppermost at one moment, and the love of technical perfection dominant at another. There are few teachers of manual training who do not at some time find themselves dangling between these two poles of thought.

Now I am restating these opposing motives in the development of the manual training idea at so much length and with so much emphasis because this is to-day the vital issue in the whole movement. And the restatement is the more necessary because the direct work of teaching manual training must rest for some time to come in the hands of men drawn from the artisan class rather than from the cultured classes, and is, therefore, in the greater danger of being regarded merely as the work of teaching a handicraft.

Moreover, this is only another aspect of the same issue which is now at stake in the universities. One can not move in the inner circles of collegiate life and thought without being constantly aware of the fact that the old breach between the classical party, the upholders of the humanities, and the newer faction representing the scientific and technical training, has never been closed. However pronounced the amenities of daily intercourse, the antagonism, at best, is only latent. When the wisdom and graciousness of humanity were all stored up in Latin and Greek, it was a prerequisite of culture to know these languages. It was early discovered that the act of acquisition was itself a most helpful intellectual gymnastic. The study thus came to have a dual value, as an end in itself, and as of high disciplinary power. This is undeniable. It is quite as true to-day as it was a hundred years ago when the classics were synonymous with culture. But the problem is now complicated by the necessary introduction of other considerations. The humane spirit of Greece is reflected more or less perfectly in the renascent spirit of modern times. The best of Greece and Rome is a heritage already ours. Further, those who would drink at the direct literary fountains can do so on the average far more perfectly in the admirable translations now available than in any translations they could make for themselves.

So far as the content of this literature is concerned, the human spirit may be as wise and as gracious without the study of the dead languages, as with it. The issue really hangs, then, upon the value of the discipline. This, too, is as great as ever, but it must be remembered that a discipline may be good—may, indeed, be the best at any one time—and yet with the progress of events become relatively poor. This, it seems to me, is the case with the classics. We are working for intellectual power. There was a time when the classics offered the best means of attaining this end. But such studies appeal only to a limited set of faculties. The best discipline is undeniably one which appeals to the fullest set of faculties, for this will mean the largest amount of brain development, and consequently the greatest intellectual power.

The objection which the classicists hold against our modern science culture as a substitute for the ancient languages is, I take it, that we have made this culture an end in itself, and have valued the facts above their effect upon the human spirit. So far as this objection is true it is a valid one. But the same spirit which once made the study of Latin and Greek the acknowledged means of culture is even more applicable in science. Like the content of Latin and Greek in the middle ages, the content of science at the present time is something greatly to be desired in and for itself as adding immeasurably to the wisdom and graciousness of life; while the process of gaining this content—a process which employs every sense and every faculty, and from its necessities evolves new senses and new faculties—represents a discipline of the highest possible value.

The classicists have preserved the spirit of true culture—a profound appreciation of the subjective value of learning.

The scientists have reached the right method—the employment and development of all the senses and faculties.

The proper reconciliation between these contending friends of culture is very simple. It consists in cherishing the spirit of the one and adopting the method of the other.

Now I believe that a similar reconciliation is possible as regards manual training. The great thing is the human spirit, the sum of human faculty. The end of education is the unfolding and perfecting of the spirit. All other ends are secondary to this. It is the great thing in the kindergarten, in the elementary schools, in the high schools, in the universities. It is also the great thing, and we are much too apt to forget this, in the conduct of mature life. We are working for power. We are after a certain quality in organized matter, a complexity of structure and a sensitiveness in the gray and white of the brain. We can accomplish this purpose, we can gain this power, we can evolve this quality of complexity and sensitiveness only by very

definite reactions upon the organism. The self-activity of the child offers such a set of reactions. It is valuable because it means development. This should be the spirit of the work in manual training. It is the educational idea of the kindergarten. But this development is at its best the result of the most careful and accurate work, the sort of work that gives products of a high degree of perfection. This should be the method of manual training. It embodies the technical idea of the universities. With the blending of these two ideas, the *motif* of the kindergarten and the method of the technical school, we shall have the manual training school *par excellence*.

It is in this spirit that I wish to present manual training, and, though I may not myself have the requisite skill, I shall still believe it possible to show that such a training for such a purpose possesses the highest possible educational value. The *motif* belongs essentially to the inner content of manual training, but it must needs be stated in the beginning, since, like the anatomy of an animal, it determines very definitely its outer form.

In speaking of manual training, then, we speak of a branch of instruction capable in precisely the same way as English or mathematics of being represented throughout the entire course of formal education. It has so happened, however, that the fullest development of manual training has been reached in the secondary schools. So much is this the case, that when one speaks without modification of a manual training school, it is understood that a high school is meant—that is to say, a secondary school—one standing between the elementary schools on the one hand, and the higher education represented by the colleges and universities on the other.

In their organization these schools resemble the typical high school. They draw their material from the same sources and require the same entrance examinations. In the majority of them the unit course is three years. There is observable, however, a decided tendency to extend the time to four years, and to make the curriculum as complete as in the best four-year classical high schools. It is encouraging to believe that this tendency results from a growing recognition of the educational *motif* underlying manual training. In several of the larger manual training schools, and notably in the two schools in Philadelphia, a very complete fourth year of post-graduate study has already been formulated. It is probably only a question of a short time before this additional year will be included in the regular course, thus making the unit four years. Such a tendency must be regarded as highly desirable, for the work which the manual-training high schools are attempting to accomplish can scarcely be realized in less time.

The course in these high schools is a very full one. A copy of the official curriculum of the Philadelphia schools will serve as a type. It presents the outward aspect of manual training more fully and more concisely than several pages of text could possibly do. Read vertically, the curriculum shows the sequence of studies in any one department. Read horizontally, it shows the current work of any one term. (See pages 54 and 55.)

Perhaps the most notable thing about the curriculum is the amount of work which is not manual training. There are five departments in the school—the humanities, mathematics, science, drawing, and manual training. We have been proclaiming for some years past, and proclaiming from the house-tops, too, I am afraid, that these are essentially high schools, and not in even a remote sense, industrial or trade schools. Yet the discovery that such is in truth the case seems to be made independently by every visitor. The curriculum is a constant source of surprise. What are we doing with German and analytics and chemistry and political economy in a manual training school? it is asked. We are doing with them precisely what other high schools are doing with them—we are trying to make them the instruments of culture. This misapprehension is doubtless our own fault. One would expect that in new schools the nomenclature at least would be accurate. But ours is singularly inaccurate. The name of one department out of five has been chosen to designate the whole, and a branch capable of representation in all grades of school work has been made to arbitrarily stand for a given grade. In this the movement is guilty of a double inaccuracy, and it is scarcely to be wondered at that the outside world has misunderstood both the content and grade of the schools.

To be very explicit, the school day begins at nine and ends at half after two. The interval, exclusive of an intermission of half an hour, is divided into six periods, or "hours," of about fifty minutes each. As there is no school on Saturday or Sunday, this gives a total of thirty hours a week. The curriculum must be realized within these limits. During the junior and intermediate years half the time, or fifteen hours, is devoted to manual work and drawing, and the other half to the academic studies. In the senior year practically the same division holds. It hardly appears so from the curriculum, since the regular manual work, the mechanical construction, covers only six hours; but then it must be remembered that much of the science work, in chemistry and electrical engineering, is done in the laboratory, and should therefore be classed as manual work, while the surveying, being practical field work, properly comes under the same head.

Before considering the manual work in detail, it will be worth while to see what is being done in the other departments. A

CURRICULUM.

PHILADELPHIA MANUAL TRAINING SCHOOLS.

Class.	Term.	Literature, History, etc.	Hours per week.	Mathematics.	Hours per week.	Science.	Hours per week.	Drawing.	Hours per week.	Manual Training.	Hours per week.
Junior (C). First Year.	1. Fall.	Literature and composition.	5	Algebra.	5	Natural history. (Geology.)	5	Constructive. Free-hand and perspective.	3 2	Joinery. Vise work. (Chipping and filing.)	5 5
	2. Winter.	Literature and composition.	5	Algebra.	5	Natural history. (Biology.)	5	Constructive. Free-hand and design.	3 2	Joinery. Pattern-making. Vise work. (Chipping and filing.) Smithing.	3 2 3 2
	3. Spring.	Literature and composition.	5	Geometry.	5	Natural history. (Biology.)	5	Constructive. Free-hand and design.	3 2	Joinery. Pattern-making. Vise work. (Chipping, filing, fitting.) Smithing.	3 2 3 2
Intermediate (B). Second Year.	1. Fall.	Ancient history. Literature. German. Composition.	3 2 2	Geometry.	3	Physics. (Mechanics.)	5	Constructive. Free-hand and perspective.	3 2	Pattern-making. Smithing and molding.	5 5
	2. Winter.	Mediæval history. Literature. German. Composition.	3 2 2	Geometry.	3	Physics. (Heat.)	5	Constructive. Clay modeling.	3 2	Pattern-making. Joinery. Smithing. Vise work.	3 2 3 2
	3. Spring.	Mod. European hist. Literature. German. Composition.	3 2 2	Geometry.	4	Physics. (Light and sound.)	4	Constructive. Design.	3 2	Wood-carving. Parquetry. Ornamental iron work. Vise work.	3 2 3 2
Senior (A). Third Year.	1. Fall.	U. S. history. Literature. German. Composition.	3 2 3	Plane trigonometry. Algebra.	4 2	Chemistry. Electricity.	3 3	Constructive. Free-hand.	2 2	Constructive work. (Machine-tool practice.)	6
	2. Winter.	Civil government. Literature. German. Composition.	3 2 3	Analytical geometry. Trigonometry.	4 2	Chemistry. Electricity.	3 3	Constructive. Architectural.	2 2	Constructive work. (Machine-tool practice.)	6
	3. Spring.	Political economy. Literature. German. Composition.	3 2 3	Surveying. Bookkeeping.	4 2	Chemistry. Electricity and steam engineering.	3 3	Constructive. Architectural and perspective.	2 2	Constructive work. (Machine tool practice.)	6

Curriculum. Philadelphia Manual Training Schools.—(Continued.)

Class.	Language and Civics.	Hours.	Mental Science.	Hours.	Manual Training.	Hours.
Post-Graduate Course. Fourth Year.	1. English. 2. German. 3. French. 4. Politics.	2 2 2 2 2	1. Psychology. 2. Ethics. 3. Logic.	2	History and principles of art. a.—Art course : 1. Drawing. 2. Modeling. 3. Wood-carving. b.—Engineering course : 1. Mechanical drawing. 2. Mechanical construction. 3. Electrical and steam engineering. c.—Course in applied chemistry : 1. Laboratory work. 2. Inorganic chemistry. 3. Organic chemistry.	1 11 11 11
	Mathematics.		Business Preparation.			
	1. Calculus.	2	1. Stenography.	2		
	Natural Science.		2. Bookkeeping.	1		
	1. Biology.	2	3. Telegraphy.	1		

manual training school is essentially a modern-language school. In addition to the mother tongue only one other language is studied, and that is German. The humanities include, besides these, history, literature, and economics. The juniors have a lesson in English every day. The work is very elementary. It is a practical drill in the use of language. It is as difficult as it is elementary. And the difficulty lies chiefly in the fact that the home forces do not co-operate. If the same number of people who now have a blind faith in the talismanic virtue of foreign languages as a means of culture could be made to appreciate the importance of an accurate use of our own beautiful mother tongue, we might reasonably hope for much better things. As it is, the daily lesson in English is a little oasis of how to use the tongue in a dreary desert of how not to use it. I have a friend, a shrewd man, who maintains that the national habit of lying is a direct outgrowth of our inaccurate use of English. The observation is worth considering.

The intermediates devote seven hours to the humanities. Two hours are given to German, an introduction to the grammar with easy reading and conversation, and five hours to history and literature. The two latter studies go hand in hand. For example, during the first term, while ancient history is being studied, the literature consists in a reading of Plutarch's Lives, Stories from the Iliad, and other books of ancient content. The same parallelism is followed in the succeeding terms during the study of mediæval and modern European history. The plan was adopted experimentally, but its success has now

made it a settled policy. The seniors add one hour to the German and now study literature, if one may so express it, in and for its own beauty. Civics are well represented under the triple head of American history, government, and economics.

The mathematical sequence is always an open problem. A contemporary philosopher who has written much that is wise and helpful as regards education contends that modern schools make entirely too much of mathematics. He holds that there are promising minds quite disqualified for such studies, and that it is unwise to force them along these lines as well as unfair to judge of their ability by reference to so alien a standard. His heresy seems likely to spread. I should agree with him were mathematics an isolated subject; but when one comes to think about it, we are dealing here not with a separate branch of study, but with an element common to all branches of exact study—the quantitative element. It is the expression of an acknowledged master that we have only so much science as we have mathematics. To omit or curtail such a study would be to omit or curtail exactitude of thought, and at the present juncture in human affairs we can ill afford such a result. The manual training school, therefore, as an exponent of modern education does well, I think, to lay full stress on mathematics, and I am only sorry that its work in this direction can not be more thorough and more extensive than it is. The present sequence begins with algebra and runs through geometry, plane trigonometry, and higher algebra to analytics. Up to the senior year the work is restricted to pure mathematics, but at this point two practical applications are introduced—surveying and bookkeeping. The sequence is much the same at all of the larger manual training schools. An inversion of the earlier part is now contemplated at the Northeast School. We propose to start with geometry. The motive for this somewhat unusual sequence is a serious one. Of the several branches of lower mathematics geometry makes the most direct appeal to the imagination of a child, and it does this by reason of its graphic method of presentation. Its concreteness makes it easier than either algebra or arithmetic. Algebra is nearly always difficult, and can best be introduced, it seems to me, after a boy has gained a somewhat more lively conception of quantity and relation than that given by the study of arithmetic. Such a sequence holds, I am told, in a number of English schools.

As it is essentially a modern-language and mathematical school, so also is the manual training school essentially a scientific school. The daily curriculum always includes a science lesson. The work begins with natural history (geology, botany, and zoölogy), progresses through physics, and ends with chemistry and electrical engineering. The two latter branches have long

been conducted on the laboratory method, and the best schools count electrical and chemical laboratories a necessary part of their equipment. It is only very recently, however, that physics and natural history have been made laboratory courses, and the usage is still far from general. It has long been desired, but in most schools practical and financial difficulties have stood in the way. These are being gradually overcome and the science work is being put upon a sound foundation. It requires some little executive ability and considerable in the way of material resources to provide laboratory facilities for several hundred boys in so many different branches, and the schools which fail in this respect must not be criticised too severely. In our own school, for example, with a capacity for about three hundred and fifty boys, we have for the manual work of all sorts, seven laboratories or work rooms in addition to two large drawing rooms and the dynamo and engine rooms, and we find the accommodation quite insufficient. The character of the science work is in all cases elementary. So little is done in this line in the lower schools that the high schools have to begin practically at the very foundation. The time devoted to science does, however, permit some material progress to be made. It will be noticed that the work proceeds with marked singleness of purpose. Except in the senior year only one branch is taken up in a term, and this concentration of effort leads to results. Even in the senior year, but two branches are taken up during the entire year, and these are too closely related to lead to a dissipation of thought.

Half the day is gone. The occupations are classed as academic, but they have all involved some form of manual work—writing, drawing, measuring, adjusting instruments, handling chemical apparatus, dissecting. The manual part has been apparently incidental, but its exercise of the senses and its reactions upon the brain have been no less certain. Let us keep this in mind, for no gulf is crossed in passing to the other half of the day, to the more obvious manual occupations of the drawing room and workshop.

A school of three hundred boys requires two teachers of drawing—one for the constructive drawing and one for the art work. They are kept very busy, too, for the classes must be as small as practicable and the lesson comes every day. The work in constructive drawing is continuous, and is kept in close touch with the workshops. It begins with the simplest sort of mechanical drawing, such as a right-lined exercise for the wood shop done in pencil on manilla paper, and passes by easy stages to the more difficult and complicated mechanical drawings of the senior year —gear wheels, bridge trusses, valve movements, and the like. The work in constructive drawing is held to be a very important part of the manual training course. Its value is both for its di-

rect bearing upon all mechanical problems and for the discipline it involves in intelligence and accuracy. It may properly be made a branch of applied mathematics, and as such has a very large thought content in addition to its manual requirements. The art work is more varied. It includes free-hand and perspective drawing, design, clay modeling, and the simpler forms of architectural draughting, as the drawing of floor plans, cross-sections, and front and side elevations. A manual training school can not be made an art school, or indeed the school of any specialty, for this would be fatal to its broader purpose of giving the faculties such general training that an intelligent choice of occupation may afterward be made. Nevertheless, the introduction to such work as it is possible to give has led in a number of cases to successful careers in architecture and kindred arts.

We have now arrived, by a somewhat circuitous path it is true, at the department which differentiates the manual training school from other high schools—at the manual training itself. This slow approach has been justified, I hope, by its success in placing the manual training work in proper relation to the rest of the curriculum, and this residue in proper relation to it. A manual training school is a unit, and as such every part of its curriculum is integral.

The boy just entering the school—he is commonly about fourteen or a little over—begins at once to work in wood and metal. He has five hours a week of each. It is found better to work in double periods, to save loss of time in putting on and off the aprons, washing hands, and so on, so that in reality he has six hours one week and four hours the next. It is a pleasant sight to see twenty-five bright little fellows at work in the wood shop. There is an air of serious earnestness about them and a sense of being all alive that promises a great deal for the future. Each has a workbench of his own and a full set of carpenter's tools at his hand. He begins by learning the use of the tools and the simpler operations of sawing and planing. When this is accomplished the first exercise is taken up. It is a simple parallelopipedon; but each face must be smooth and true, each angle exactly a right angle, and each dimension accurate. There is more in the work than appears at first glance, and few of the little workmen escape spoiling one or two pieces before they fashion an exercise that will bear the rigid examination of the teacher. The next exercise involves chiseling and is a little more difficult. Then come joints of various sorts, framing and nailing exercises, boxes and drawers. About a dozen exercises are finished in the joinery department during the first year. The rest of the wood work is in pattern-making and starts with the opening of the second term at New Year. This requires greater nicety of touch,

and involves lathe work in turning as well as the use of the simple hand tools. Four or five patterns are made during the first year. As far as possible each one brings out some new principle and is made a trifle more difficult than its predecessor. The work requires not a little patience and perseverance, for no pieces are accepted which show either inaccurate dimensions or careless workmanship. These two departments comprise the wood work of the year.

Meanwhile the metal work has also been progressing. Each boy has his bench with its vise and accompanying tools, chisels and files, calipers, and rules. The work of the first term consists entirely of chipping and filing. The rough blanks of cast iron have approximately the form of the finished exercise, but they are larger in all their dimensions and their faces are just as they come from the molding sand. To dress them down to the right dimensions, to make the faces smooth and true, the angles right, and later to fit the pieces together so that no line of light shall be visible when they are held up in front of a window or no jamming or friction noticeable when they are taken apart—all this requires nice workmanship, the sort that comes only when we put a great deal of effort into it. It is exacting work and must not be carried too far, or the little workers grow discouraged. Smithing is also begun during the first year. With the opening of the second term the vise work is reduced to three hours a week, and the two hours thus gained are given to smithing. The first exercises are very simple, mere bars of given dimensions, and are done in lead before they are attempted in iron. The use of the tools and the proper way of handling the pieces may thus be learned more leisurely than is possible with red-hot metal. The anvil chorus is here given every day, the little Vulcans half masters and half mastered in the new set of conditions attendant upon the glowing forges. They are taught to draw the metal, to upset, to weld, to forge, and in general to go through all the typical smithing operations. The work is decidedly picturesque. It introduces a new element, that of time, for the metal must be fashioned while it is hot, and makes therefore a new demand upon the worker—he must needs be alert as well as painstaking.

The majority of schools do not follow quite this sequence in their manual work. It is customary to make the joinery and vise work of the first term extend uninterruptedly throughout the rest of the junior year. The plan of making the joinery alternate with pattern-making and the vise work with smithing has been introduced at the Northeast School for a double reason. The vise work, by its very nature, is slow and rather monotonous. It seems to us unwise to dull the boy's interest in his work at the

very outset, by setting him tasks which weary him out of proportion to their advantage. Moreover, there is a distinct technical loss in completing the vise work during the first year. It must be taken up again in the constructive work of the seniors, and the year's interval without practice means that some time must be devoted to regaining the lost skill. By extending the vise work over the junior and intermediate years no such gap occurs, and we hope for increased efficiency in the senior shop work. The alternation in the wood work is not so necessary, but even here there is a certain gain in the variety of occupation, and no loss in the way of dissipation of energy.

This plan has only been in operation for the one year, so that its full effects are not yet open to study. Such results as are before us favor its continuance.

Let us pass now to the second or intermediate year. The work begins, as in the junior year, with but two subjects. In wood it is pattern-making, and in metal smithing and molding. Each has five hours a week. The pattern-making is a continuation of the work already started, and includes problems of increasing difficulty. The metal work opens with molding. Lead is used for making the castings on account of its low fusing point. It would not be practicable in schools of this grade to operate a cupola furnace and cast in iron. The same principles are illustrated in the use of lead. When this part of the course is completed the work in smithing is resumed. In the latter terms there is the same bifurcation in the wood and metal work as in the junior year. The pattern-making now occupies but three hours a week, and in the last term gives place to wood-carving. Each boy makes either a complete panel himself or executes a part of the carving on some larger project, such as a chair or chest. The thirty-six hours given to the subject do not permit any very elaborate undertakings. The remaining two hours in wood work are devoted to the construction of some finished project in joinery, such as a shutter or door or staircase, and to the putting together of a panel in parquetry. Smithing and vise work alternate during the second term of this year, and in the third term the smithing gives place to ornamental iron work. No formal exercises are introduced, for the previous work in smithing has served the purpose. The ornamental work is entirely in the shape of finished projects, such as grills, electroliers, lamps, andirons, brackets, and the like. Some of these are of considerable beauty. As with the wood-carving, the limited time does not permit very elaborate accomplishment. I place a high value, however, on both of these lines of work. They are technically admirable. They have a large subjective value, and they do not a little toward the cultivation of the æsthetic sense.

In the senior year the manual work shows entire singleness of purpose. It is somewhat technical in character. The machine shop devoted to it is equipped with machine lathes, drill, planer, shaper, and vises. It has quite the appearance of being ready for serious work. The early part of the year is given to a series of formal exercises—turning straight and tapering cylinders, cutting right and left screw threads, shaping irregular parts of mechanisms, drilling, fitting, and going through the manifold operations required in machine construction. In the latter part of the year a series of mechanical projects is undertaken. These vary from year to year, and are simple or elaborate according to the capacity of the group of boys constructing them. They include such mechanisms as steam engines, centrifugal pumps, force pumps, overhead carriers, screw propellers, dynamos, and motors. The finished projects have the advantage over simple exercises of requiring a nice interchangeability, and giving splendid practice in the assemblage of parts. At the end of the year the total amount of work done is not very large. It looks, indeed, almost insignificant in comparison with the elaborate mechanism needed for its production. It will bear examination, however, and it has involved many operations and many principles.

The output of work in the manual department represents two classes—formal exercises and finished projects. The first are almost as abstract as a problem in geometry. They are numbered, labeled, and graded. They have the flavor of the schoolroom about them. The second are more concrete. They represent intrinsic worth in addition to the lesson they have taught. They have, however, no industrial value. They are never sold. They remain the property of the school, lending their beauty to the furnishing of the building, and also serving as an example and incentive to succeeding classes. They have as high an educational value as the more formal exercises, for they are carefully chosen and embody principles which are quite as general. In the early days—that is to say, some eight years ago—when manual training was less secure in its educational position than now, I used to be much afraid of anything which betokened a value apart from the little workmen themselves. The production of finished articles seemed to indicate the shop rather than the school. This was the cause of my distrust. But now my feeling is different. I begin to set a higher value upon these completed projects. I see that it is possible to make an object of beauty, and even of utility, and get quite as deep a lesson out of the operation as if the object were ugly and useless. One may require the same careful workmanship, the same strict regard for dimensions, and may bring into play the same set of muscles in the one as in the other. In addition, there is the advantage of a keener interest. More work

is done, and it is done, I believe, in a livelier and happier spirit. It is quite possible that the boy himself places a higher value upon the project than upon the process, but no harm is done. It does not change their relative values. I am disposed to believe, too, that the more unconscious the spirit in which a boy works the finer will be his results. It is not necessary to be forever suggesting to him that he is being educated. It is quite enough if we older people keep that in mind. The boy himself had much better be engaged with the activities through which we propose to educate him. When one has been teaching for some years—let us say for seven, so that I may speak from experience—one comes to value increasingly the quality of unconsciousness. The machinery of education ought to be kept strictly out of sight. The child nature is at its best when it is spontaneous. The post-graduate course is still tentative. The chief feature in the present plan is the elective character of the manual work. Three courses are offered—in art, engineering, and chemistry. It is possible that, with the incorporation of the fourth year into the undergraduate curriculum, groups of parallel studies will be made elective.

I have been trying to tell, in a very plain and unvarnished way, just what we do at a manual training school. In the next paper I hope to tell why we do it, and, having done it, what it leads to.

THE SWISS WATCH SCHOOLS.

By THEODORE B. WILLSON.

ONE need not be specially interested in watchmaking in order to be fascinated with what he will see of watches and watch work in Switzerland.

The great number of jewelers' shops in the cities, displaying watches in every conceivable form and setting—as eight-day watches, watches in pencils, studs, cane-heads, bracelets, rings, etc.—will be sure to make him loiter fascinated in front of each window he passes. For minute and ingenious work the Swiss outdo the world. Indeed, to what an extent the Swiss are furnishing the world with its pocket time may be guessed from the estimated exports in that line, which are now said to exceed twenty million dollars annually, and this figure can hardly include that unknown amount of such wares bought to some extent by almost every tourist as a present or a souvenir. In almost every European country the watches offered for sale are in large part Swiss. The only rival of the Swiss watch is the American, and even here, despite our development of the industry and high tariffs, the smaller patterns are chiefly Swiss.

The writer was greatly interested in this nation of watchmakers, and gave some attention, during a recent visit to that country, to the Swiss methods of making watchmakers, as well as of making and marketing watches.

The Écoles d'Horlogerie—schools of watchmaking—are under the municipal management in Switzerland precisely as are our common schools. Special permission must be obtained by any one desiring to visit either the watch or the common schools. There are watchmaking schools at Geneva, Neufchâtel, Chaux-de-Fond, Locle, Bienne, Ste. Imier, and Porentruy.

FIG. 1.—PLATE.

The idea of going to school to learn to make watches would strike an American schoolboy as queer enough. Doubtless many of them who find the arithmetic and geography and grammar to go rather heavily, but who are fond nevertheless of seeing "the wheels go round," would think it a blessed existence to study nothing at school except these wheels, how to make them, and make them go round. But the reality loses the novelty and charm with which the American schoolboy might invest it long before the slow, thorough, exacting work is done which entitles the Swiss boy to graduate an accredited watchmaker.

The school the writer visited is the extensive one at Geneva. Being provided with the requisite permission, and escorted by an "alumnus" of the institution, he was shown every courtesy and afforded every opportunity to observe.

One is first ushered into the beginners' room. To enter, a boy must be at least fourteen. He will first be introduced to a wood-turning lathe and set at turning tool handles. He will be kept at this from eight days to several weeks, according to aptitude. Then he will be advanced to the work of filing and shaping screw-drivers and similar tools. These, and all other tools which he may afterward make, will be his own. Being in course of time to some extent provided with tools, he will undertake making a large wooden pattern of a watch frame perhaps as large as a dining plate. After he has learned just how this frame is to be shaped, he is given a ready-cut one of brass of the ordinary size, and he begins drilling the holes for the wheels and screws (Fig. 1). All along the masters stand over him and instruct him. The circular pieces of brass which are put into his hands here

he will go on with, and when the watch is completed that, too, will be his own.

He is then taught to make other fine tools, and to finish the frame, ready to receive the wheels.

Then he will leave the first room, and pass up into one where he is taught to fit the stem-winding parts, and to do other fine cutting and filing by hand, to make watches that will strike the hour, minute, etc., for which class of work the Swiss are so famous. One can readily conceive how exceedingly minute and exact such workmanship must be, particularly on the minute snail—that is, the guide which permits and arrests the striking, so that, in addition to the hour and the quarter, the very minute shall be sounded.

The master in this room had been thirty-eight years in that office, directing, inspecting, criticising, and it was interesting to

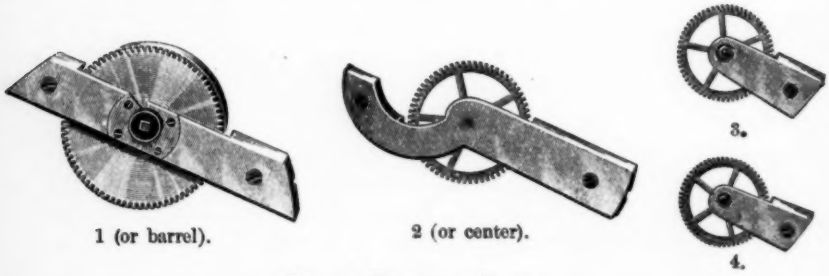

FIG. 2.—WHEELS OF TRAIN.

observe that his eyesight was still perfect, a fact which tends to confirm the statement sometimes made that it is rare to find a working jeweler an inmate of an eye infirmary.

When the student has mastered the work on these fine file-dressed parts, he is ready to pass on into the train room—i. e., the room in which the wheels are cut. Here he will be taught how to handle the beautiful little machines which cut the cogs. Some of them are so fine that they can be adjusted to cut twenty-four hundred cogs on one small wheel.

In this room are to be seen large working models of watch movements, perfect watches in every respect though large as a saucer, which enable the student to study very important matters of the angles of cogs, the bearing and adjustment of the matched parts, etc. Many of the numerous jewelry shops over the city have these mammoth watch movements running in the windows as a means of engaging the attention of the passer-by of mechanical tastes.

The next step upward is into the escapement room, where those steel parts that constitute the escapement—the scape-wheel, lever, and balance—are cut (see Figs. 4, 5, 6).

The essential difference between the American manner of making a watch and the Swiss is brought to mind in the course of your stay in this room. Take the lever in illustration. The American manufacturer cares little how a lever looks, provided only it serves its purpose properly. The Swiss workman, however, must needs dress down the lever until it shall have a delicacy and comeliness all its own. The difference between a Swiss and an ordinary American lever has been likened to that between an antelope and a bear (compare Figs. 3 and 5).

FIG. 3.—AN AMERICAN LEVER.

Having remained in the escapement room long enough to master the principles and the practice required for making those delicate and critical parts the boy, or rather young man—for he has added several years to his age by this time—is ready to enter the last or timing room. Here he learns to do the very fine work which makes a watch a fine timekeeper. Without this work a watch may run a little faster when wound up tight than when partly run down. It will often run a little faster in the cold than in the warm pocket. It may not keep quite the same time when hung up that it does when lying down.

To get rid of all these imperfections requires very careful, patient, and skillful work. It will suffice for the ordinary reader if we give but a few suggestions as to the manner of procedure.

The tendency of a watch to vary by reason of the varying pressure of the mainspring is overcome by means of the hairspring. Experimentation has proved that if certain peculiar

FIG. 4.—SCAPE-WHEEL.

FIG. 5.—SWISS LEVER.

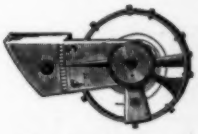

FIG. 6.—BALANCE.

curves and inclinations are given to portions of the hairspring it will compel the balance to beat equal time for a longer or shorter swing. What these curves are the student learns from drawings which he follows as closely as he can, and then proceeds on the "cut and try" principle. Timing for heat and cold is a simpler matter, and is accomplished by adjusting the screws on the balance. Every respectable balance is made, by means of a combination of brass and steel hoops, to adjust itself more or less accurately in changes of temperature. But to bring about great accuracy in this respect requires much patience and experimentation. Then comes the adjustment for changing positions. If a watch runs a little faster lying down, the bearing affected by that

position must be made a little coarser. Here the "cut and try" method must again be patiently applied.

At length, when the young man can get his watches so that they will not vary more than two and a half seconds a day, whether cold or warm, and no matter how many times they are changed in position, he is entitled to a certificate from the astronomical observatory where the watches are tested, that he is a competent watchmaker.

In the United States men or women or boys learn to run, perhaps, one little machine in a large factory, which cuts or polishes one small part, and do not try or need to understand the whole trade of watchmaking. But in Switzerland the man who makes a watch or any part of it is a watchmaker always, although he will sooner or later decide what part of watchmaking he prefers, and manufacturers will then bring him just that work to do. One man may make a business of merely polishing screw-heads, another does nothing but time watches, etc. There are no large watch factories in Switzerland, such as we have, but all their myriads of watches have been passed round through the little shops of these watchmakers before they have got all their parts and are ready for the pocket.

One of the consequences of the Swiss mode of making a watch is, that its every part is made for that particular watch. This is true not only of the movement but the case. Cases are not interchangeable as with us. Each case is made to fit a given movement, and will not, unless by sheer accident, fit another. A dealer requiring watches must give his order—say for a dozen—to the watchmaker who is making a specialty of the earlier parts of the work, and then the dealer must follow his order on until it is completed and cased.

After observing the thoroughness of the training of which the Swiss workman has the advantage, one hardly wonders that the Swiss are able to produce at once the quantity and quality of watch work for which they are justly famed.

Concerning famines in India, which were formerly often terrible, Mr. C. E. D. Black, in his third decennial report of progress, does not deny the existence of "habitually starving millions," but maintains that, taking the country as a whole, it can always furnish food enough for all its inhabitants. The difficulty has hitherto been in moving the surplus of one or other locality to the spots where deficiency exists. This has now been mainly overcome, and the days when grain was selling at famine prices in one district and rotting on the ground in another are gone. Registered meteorological observations indicate that, as a rule, two thirds of India are affected each year, either favorably or prejudicially, differently from the other third. There is no record of a universal failure of crops, any more than of a general harvest above the average.

THE COBRA AND OTHER SERPENTS.

By G. R. O'REILLY,
CORRESPONDING MEMBER OF THE ROYAL ZOÖLOGICAL SOCIETY OF IRELAND.

DURING a three years' residence in southern Africa cobras and other snakes were my pets and most intimate companions. They occupied my bedroom; they sunned themselves in my windows; they coiled themselves in my armchair and on my study table, and made themselves quite at home among my book shelves and bric-a-brac. Baby cobras were born into my hands, and adult cobras accompanied me coiled in my pocket whenever I went out to take sly observations, through a binocular glass, of the movements of their brothers and sisters still free among the rocks and bushes of plain or hillside.

Above all his peers in the ophidian kingdom, the royal cobra claimed my chief attention. His beauty, the web of Oriental romance in which his name is intertwined, and the dreadful destruction of human life with which he is credited, make him to all of us an exceedingly interesting animal. As man alone stands up and walks erect, the acknowledged king among living things, so it is only the cobra of all the reptile kind that raises himself perpendicularly from the ground and expands his neck as if in fancied pride of his power to dispute with humanity the supremacy over animal life. Year after year, over the whole of southern Asia, but especially in the Indian Peninsula, a vast multitude of men, women, and children fall victims to his deadly fangs. If each year, within the bounds of British India alone, a town of ten thousand inhabitants were to be utterly depopulated by a painful form of death, and if this calamity had been constantly recurring, as far back through the centuries as history has record of, who would not be filled with commiseration for a people so afflicted? And yet in that same country this number of human beings is annually carried off by the bite of poisonous serpents, and the world looks for it as a matter of course. Thus the dreaded cholera itself is not a greater destroyer of human life, as it is but an occasional visitant. As the cobra is blamed for nearly all this appalling mortality, we need not seek out further reason for giving him the title of "king of deadly serpents."

Sir Joseph Fayrer, in his magnificent Thanatophidia of India, gives us copious information regarding his poison, its terrible work among the Indian peoples, and the various methods of counteracting its effects; and more recently our own able inquirer, Dr. Weir Mitchell, has given us its analysis. But as regards the story of cobra life itself, cobra capabilities, and cobra idiosyncrasies, we are still at the mercy of Pliny and his success-

ors. From book to book the old yarns of his fondness for milk and his susceptibility to music are handed down as heirlooms, and will continue to find believers until writing naturalists keep living cobras at their elbows.

Under the general name "cobra" are included several species, differing little in general appearance. They are found all over southern Asia and throughout the entire continent of Africa. In India, *Naja tripudians* is common; in North Africa, *Naja haja;* and in South Africa, *Sepedon hæmachates.* In the other continents no true cobra exists. They are all hooded snakes, and

FIG. 1.—COBRA DI CAPELLO (*Naja tripudians*).

all exceedingly venomous. In color they vary much; some are yellow, some are brown, others black—while in general all are banded more or less distinctly with regular light and dark rings. They are usually about four feet in length and two inches in diameter, but can attain to six feet.

All terrestrial deadly serpents may be divided into two groups —the *Viperidæ,* which have the head covered with small, irregular scales; and the *Elapidæ,* which have it covered with large, regularly disposed plates. Taking the rattlesnake as the representative of the *Viperidæ* and the cobra of the *Elapidæ,* it will be instructive to note some of the differences between these two famous poisoners. The head in the rattler is broad and flat and

the neck very thin; its body increases in diameter toward the middle and gradually tapers off to the tail. In the cobra the head, neck, and body are of the same thickness until the tail commences. In the rattlesnake the eyes have a vertical pupil, like a cat's; in the cobra the pupil is round. In the rattlesnake the fangs are long, well curved, very movable, thin, and with the end of the poison duct coming out almost in the same line with the point of the fang; in the cobra the fang is very short, slightly curved, scarcely movable, strong, and with the end of the poison duct coming out at a large angle with the point. In disposition the rattler is much more sluggish and not nearly so timorous as the cobra. To meet an assailant, the rattlesnake will arrange himself coiled carefully, like a spring, in a horizontal position; while the cobra prepares no coil, but raises himself up on high perpendicular from the ground. As to the manner of securing their prey, the rattlesnake is like a cat: he lies in wait for it in a suitable locality, and then springs on it unawares, generally waiting till its death struggles have ceased before swallowing it. The cobra, on the contrary, hunts up his victims, pursues them like a dog, and swallows them alive when caught. There is also, as Dr. Weir Mitchell has shown, a marked chemical variance between their poisons.

All these differences are, as a rule, applicable to their respective classes; and it is worthy of mention that in the several points enumerated, excepting as regards the poison arrangements, the *Viperidæ* agree with the true boas and the *Elapidæ* with the colubrine or common harmless snakes. So it will be understood that the cobra is rather a cousin to the black snake than to the rattler.

In searching for his prey, he glides about without anything remarkable in his appearance to denote that he is a cobra; but, when excited by fear or anger, he raises his head and from one third to one half of his body perpendicularly from the ground, while the remainder is gathered beneath into a coil of support. At the same time the upper ribs, from the head downward for five or six inches or more, spread themselves out laterally, carrying the skin with them, thus making of his neck part a thin, flattened oval disk four or five inches broad. This wide flatness of the neck is called the "hood," and above it the head appears pointing horizontally to the front. His disposition is so extremely nervous and timid that he will strike at a moving adversary long before he comes near enough to reach him with effect. If you stand before a cobra thus erect and alarmed, and move alternately your left and right hands up and down, he will strike repeatedly to the left and right, following your motions, bringing his head and neck flat on the ground each time, and at every stroke drawing closer to you. In striking thus he hisses audibly

and instantly reassumes his erect position, and thus he continues to act as long as danger menaces or a safe avenue of escape does not present itself. This turning to the left and right after one's movements and striking downward is the so-called "dancing," which superficial observers have attributed to the power of music. Even after a slight acquaintance with snake dancing I began to suspect that music had nothing to do with it. Before long I was convinced on the subject.

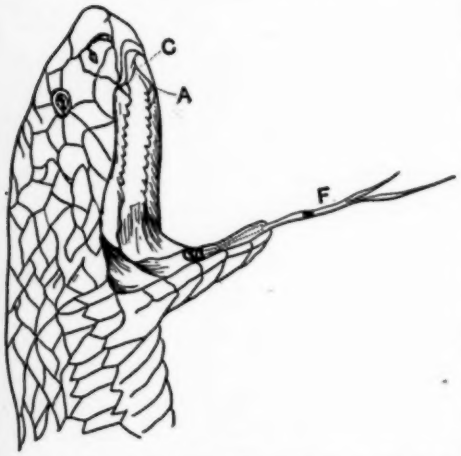

FIG. 2.—HEAD OF THE COBRA, SHOWING GAPE OF THE MOUTH.

It happened, I believe, in 1877, that Sir Bartle Frere, Governor of the British dominions in South Africa, when on his way eastward to settle some troubles preceding the outbreak of the war with the southern Kafirs, paid a visit to my collection at Grahamstown. He arrived unexpectedly and found me on my knees with my sleeves rolled up, washing out my floor, for it was impossible to get a servant to enter the room. Seeing there all the snakes of the country living before him, he was intensely interested, and at once singled out the cobra as an old acquaintance, for he had spent much of his life in India. Many things he told me of Indian snake-charming; but when I made the cobras dance, faint away as if dead, and by a touch return them to life again, he asked in some astonishment how it happened that I did so without the aid of music. I explained the "dancing" as the natural tactics of the cobra in defense and attack, and the fainting and recovery as consequences of an extremely nervous and overexcitable temperament. But my visitor clung to his old opinion, saying that my belief that they never really danced to the music was opposed to the teachings of natural history and to the experience of every one who had lived in India.

Next day, when the astute Sir Bartle was on his way to the frontier to charm the turbulent chiefs with diplomacy, I invited a flute-player to charm my snakes. I myself went into the room to note results and sat down in my usual place among my pets, leaving the musician outside in the hall, so placed that the snakes could not see him. He played his sweetest tunes. The "Last Rose of Summer," "Annie Laurie," and "Home, Sweet home" had no effect, so I called to him to play something quick

and lively. Accordingly, he gave us "Pop goes the Weasel," "Miss McLeod's Reel," and "The White Cockade"; but never a snake moved. I then invited him inside, but the result was the same, the flute was a failure. Next day I tried the violin. The performer again sat outside, but all his efforts were useless; both quick and slow music were alike lost upon them. On my invitation he came in and sat still a few moments preparatory to commencing afresh. He soon thought himself an Orpheus; for as he began playing, the cobras stood up on the floor. "Aha!" said he, "see that!" However, believing that they were only alarmed at the quick movements of his arm, I stood over between him and them, thus cutting off their view, whereupon they showed that their fears were quieted by gently lowering themselves to the floor.

On the table was a glass-fronted wooden box in which was a large puff adder. I got the musician to sit close opposite to this and play his loudest, but the snake never showed the slightest sign. Then at my request he went round behind the cage and let one end of the violin rest on the top of it. At first he played the higher notes, and the snake showed no sign; but when he touched the deep bass chords the animal swelled himself up and began to blow as if alarmed. Thus from the instrument resting on the wood of the top the vibration was conveyed to the whole box, and the snake *felt* it throughout his entire body where he lay in contact with it, in the very same way that I myself *felt* it when I laid my hand upon it.

Many trials were made with other instruments, but always with the same results, viz., 1. Music from an unseen performer had no effect whatever. 2. If the performer were seen, any noticeable movements of his would alarm the snakes, but in exactly the same way as if he made no noise at all. 3. They gave signs of disturbance when the vibration, especially of bass sounds, was communicated to the material on which they lay.

Thus was proved not only that cobras do *not* dance to music, but that, far from being charmed with the melody, the poor animal is only *frightened* at the movements of the musician, and that the apparent dancing and bowing are only so many half-hearted attempts to strike at the performer or some one moving in his vicinity. Furthermore, I was led to the conclusion that *snakes can not hear any sound* with sufficient distinctness to determine their acts, unless it is so great as to cause objects in contact with their skin to *vibrate sensibly to the touch*, and that even then they can only be said to feel *the sound's effects*.

At the present moment as I write there is on the table before me a glass-fronted box in which are some of our common garter snakes. On the top of this box is placed an alarm clock. Now,

when the alarm goes off in this position the garters always move a little, for the vibration is communicated to the wood and can be plainly felt with the finger-tips; but when the clock is on the cloth-covered table close by and not in contact with the wood on which they lie, they never give a sign of having heard it.

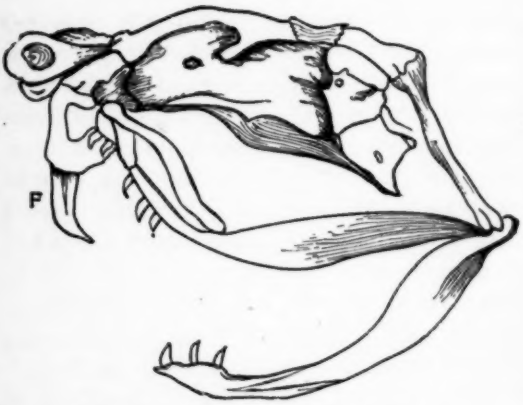

FIG. 3.—SKULL OF POISONOUS SNAKE.

When I lived on the island of Trinidad, I had a large collection of West Indian and South American serpents which it was necessary to feed on animals of many different species. It was always noticeable that neither boa, viper elaps, nor coluber ever gave the slightest heed to the voices of these, while at *sight* of the *moving* prey they manifested very evident signs of recognition. Snakes as a rule are very timid, and as I often had visitors at feeding time, it used to be necessary to warn them that any stirring about of arms or legs would be sure to delay the dinner; but no restriction was ever needed to be placed on conversation, except that the turning of the head was forbidden—each had to talk straight to his front, no matter whom he addressed.

During the past four or five years I have hunted extensively over the woods of northern South America, from the Bay of Panama to the Delta of the Orinoco, often alone, sometimes with others. Now, when I had company it would be frequently necessary to call on their assistance in capturing some of the long, swift-running snakes. If one of these were discovered some distance off, resting close by a fallen tree, it was my method to go round to the other side of the old trunk and come up unseen, often within a yard of him. There I would shout directions to my friends, sometimes at the top of my voice, where to post themselves and where to head him off. This shouting never caused the snake to stir; but should I show the rim of my hat moving up even a hand's breadth over the intervening trunk, he would be off like a racehorse; for the eyes of a serpent, though dull to note form and color, are exceedingly quick to detect motion.

Now, it may be mentioned that snakes have no external ears, their heads being entirely covered, like the rest of the body, with a tough and scaly skin. Yet in how far they may be able to

detect sound waves in the air, as a general evidence of something unusual, with the delicate tip of the restless bifid tongue, is a subject that requires investigation; but that they can appreciate music in this or any other way is, as has been said above, absolutely untrue. How such an idea as that snakes are fond of music and milk ever gained credence among men calling themselves scientists only shows how few really scientific observers we have.

Men sometimes do strange things for the love of knowledge, and it was this love which caused me to live on such intimate terms with my scaly but graceful and gentle friends. I took them into my house to live with me. This was the best way to know them perfectly; and the more I knew them, the more I knew that they did not know me. I soon found out that neither cobras nor any other serpents can ever become capable of attachment, nor even distinguish one person from another, nor distinguish a man from any large animal, nor even distinguish a man from a tree stump until he gives evidence of his life by motion.

During my stay in South Africa I had many cobras, all of which I captured myself, except those born in my collection. Now, cobra-hunting is a very dangerous kind of sport, and had I known of its perils otherwise than by experience it is probable that I never would have attempted it. The first two or three I caught safely, and nothing particular occurred to show that there was a special danger in taking *them* which did not equally exist in the capture of other deadly snakes. But I found out that in three important particulars of defense and attack the cobra differs from all his fellow-poisoners: 1. He rarely opens his mouth when striking, but actually gives a deadly blow without biting. 2. He bites deliberately when he is in a state of apparent death from muscular contortion, and will then hang on like a bulldog, the venom flowing all the time into the wounds in which his fangs are buried, until he drops off at last from sheer exhaustion. 3. He can squirt the venom from his fangs into a person's eyes, and thus blind him for a time at least.

I had often heard of the "spuugh slang," or *spitting snake*, but, looking at the thing from a *too human* point of view—as we are all, unfortunately, overmuch inclined to do when considering animals—I could not understand how a snake, not having fleshy lips and a bulky tongue, could be said *to spit* as we understand the word; and hence could no more believe in spitting snakes than I would in unicorns or fiery dragons. However, the result proved that oftentimes a story which on the face of it seems impossible has, after all, a certain fund of truth lying concealed somewhere at bottom.

One day, being alone in the bush, I saw a cobra banded with black and white. He was in an open glade, gliding about through

the herbage, delaying a little perhaps for an opportunity to get at some birds that were chattering and hopping about on the branches of a thorny, yellow-blossomed acacia. The sun was blazing down fiercely on him as, with half-distended hood held close to the ground, he slowly passed through the leaves and flowers. For a few minutes I watched his movements through my binocular glass; but, fearing he might notice me and escape into some hole, I picked up my six-foot hunting stick and rushed toward him, intending to press his head to the ground with it, and then take him by the neck with my hand. He saw me coming, and, like a valiant warrior that knew his power, he faced round and stood erect with expanded hood and quivering tongue ready to receive me. His bright black eyes sparkled with energetic defiance, and every fiber of his being was electrified with excitement. While I was yet ten feet away he struck toward me with such force that the impetus carried him flat to the ground. In trying to get my stick across his neck he dodged it, and it came instead across the middle of his body. At this moment he was between me and the sun, with about five feet between his face and mine. I looked into his eyes and held him down firmly. His rage seemed redoubled. He leaned backward to make a more vigorous dash at me, and as he struck forward the mouth partially opened, and two tiny streams of venom shot from his fangs as from a syringe, one of them catching me on the face just beneath the eye. Had it gone a little higher up I should have been blinded for months, and perhaps had my sight permanently injured. This unexpected attack made me hasten the capture; so, getting his neck pressed down to the ground with the stick, I soon had him grasped in my hand just behind the head in such a way that he couldn't possibly turn to bite me—which he made every effort to do for some minutes afterward. Taking him home with much satisfaction I made him thereafter my fellow-lodger. While living in his cage, I observed him many times squirt the venom from his fangs against the glass of its front. Thenceforth my doubts about spitting snakes were removed.

In order to understand how it is that he can eject the venom as high as a person's face—which we never hear of the viperine snakes doing—it is well to consider carefully the approximate difference in the fangs of the cobra and those of the rattler. Snakes of the class *Viperidæ* can and do under certain circumstances eject the venom somewhat similarly, but their methods of striking are more deliberate usually, and instead of the first and more copious discharge being thus lost, as is often the case with the cobra, it is, on the contrary, injected into the veins of enemy or prey. This premature squirting out of the fluid in the cobra is not to be taken as a voluntary act. It has

been mentioned above that he is so excitable that he will strike at a moving adversary long before he comes near enough to actually hit his object; and it is in striking thus from a distance that the poison-controlling muscles act as if he really struck something, and the distended gland gives way to the pressure, forcing the contents, which in other circumstances would have been injected into the flesh, to go instead in two thin streams through the air.

In regard to the manner in which the cobra strikes with effect without opening his mouth, it is necessary to state that while the fangs of the rattlesnake and other viperine snakes are laid horizontally back along the upper jaw when the mouth is closed and only erected when the mouth is widely open, it is not so in the cobra; but whether his mouth be open or shut, his fangs are always partially or wholly erect, and not in the true sense of the word reclinable. Now, usually when he strikes at an adversary his mouth does not open as does the rattlesnake's, but he simply hits with his chin the point he aims at, so that, the mouth being still shut and the fangs during the act coming out over and slightly below the lower lip, these protruding fang-points penetrate the skin, while at the same instant the potent venom is squirted with force through these natural hypodermic syringes into the superficial punctures. Hence it is that on the bare legs of the natives this so-called "bite" is usually fatal, while the slight protection of trousers saves the European from danger.

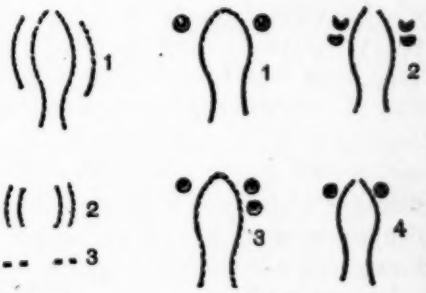

FIG. 4.—PUNCTURES OR BITES OF SNAKES.

As to the third peculiarity of this snake—viz., the fit of temporary lockjaw into which he is liable to fall and the terribly prolonged and real bite he can give when in that state—the account of an interesting adventure I once had will give a fitting illustration. It was a most wonderful exhibition of reptilian hysterics.

In the midst of a South African summer, when the springs and rivers are dried up, the snakes congregate in unusual numbers around the dams which are built by the colonists to store up in the ravines for themselves and their cattle the drinking supply afforded during the rains by the mountain torrents. At one of these reservoirs in Currie's Kloof, near Grahamstown, I had secured several fine serpents, and was not surprised therefore when one afternoon, as I was sitting by an upper window, I saw a boy running from that direction toward the house, shouting as loud as he could bawl, "A snake, sir—a monster snake!"

I ran downstairs and found him breathless and pale with excitement at the door. The snake, he said, was fully twenty feet long. It had pursued him a little way through the bushes and then disappeared in a hole in the bank. "Aha!" thought I, "this must be the great Natal python I have heard so much about but never seen." With some doubts, nevertheless, about his being twenty feet long—for people usually imagine snakes which scare them to be much bigger than they really are—I took my snake-hunting stick and set off at once to make the capture. On arriving at the pond, which was overhung by poplar trees and nearly dried up, the boy led me across a long stretch of hardened, sun-baked mud to a point in the great earthen dam about twenty feet over from the water's edge, where there was a hole, the mouth of which he had carefully stopped up with a good-sized stone before coming to tell me. This I removed, and as the snake was not there ready to bolt out as I expected, I ran in the stick to dislodge him. This, however, had no effect. So, taking a piece of stout paling wire, I made with it a hook to the end of my snake stick. Running in this arrangement, I managed to catch it in his folds, a proceeding which he resented by slipping it off and by many angry hissings which sounded all the louder from being uttered in the confinement of his subterranean retreat. After several failures he was at last hauled out. "A cobra, by Jove!" said I, as he raised himself up erect with expanded hood on the hard-mud expanse between me and the water. As his head when standing thus was fully eighteen inches high, it was no easy matter to press his neck to the ground so as to catch him safely with my hand. Without at all hurting him I made several attempts to get his neck down, and not without some nervousness, for he might at any moment send a charge of venom into my face. This playing him with the stick to get him into proper position so aroused and alarmed him that at last, overcome by his own excitement, he suddenly collapsed, falling over on his side and lying there motionless, half on his back, with his mouth fixedly open and stiff as if in death. His whole body was rigidly contorted and as unbending as a dried stick. "Ah, you've killed him!" shouted the boy from the top of the dam, whither he had retreated for safety. However, as I had seen this manifestation before, I knew that it was only a hysterical fit. Warning the lad not to approach, I picked up the apparently lifeless snake by the tail-tip and flung him off from me to a distance of five or six feet. As soon as he touched the ground all his life was active again. Up he stood instantly with expanded hood as before, the black eyes glistening angrily and the forked tongue running out quiveringly from the closed mouth as if daring me to approach. A slight touch with the stick on the neck caused him to fall down in a second fit simi-

lar to that from which he had just recovered. There he lay again, to all appearance dead, with every muscle rigid and his jaws fixed in a partial gape as if sudden dissolution had prevented their closing. Seeing in this an opportunity of giving the boy a lesson against the danger of meddling with seemingly dead cobras, I called him down to my side. "Do you think that snake is dead?" said I.

"Yes," he replied, "I believe he is surely dead now; you must have given him his death wound getting him out of the hole."

"Well, my boy, I'll show you whether he is dead or not; and from what you will see, take warning that a bite from an apparently dead cobra like this is a thousand times worse than if he were to strike you perchance in the usual way as you pass through the bush."

So saying, I put the end of the stick into the stiff, gaping jaws. Instantly they closed on it like a vise until the fangs were buried in the wood. Then, lifting him up till his tail swung clear of the ground, I bade the boy count the time by his watch, to see how long he would retain his bulldog-like grip. The body was gathered into unbending curves; but, as the minutes went by, these straightened out, commencing at the tail and advancing gradually upward to within three inches of the head. At last this too became limber, the jaws unloosened, and he dropped to the ground as the boy exclaimed: "Well, I'll be blamed! that bulldog snake held on for eight minutes and a half." As he lay now exhausted on the ground he put out his tongue at intervals, but never otherwise moved until I attempted to put the stick across his neck preparatory to taking him, when he stood up for fight as fresh as ever. However, I was nimble with the stick, and by its aid got my fingers round his throat just as he went into his third fit, and held his deadly jaws open again ready to close upon anything they should chance upon. Thus open-mouthed he remained as I carried him homeward, but recovered from his fit as he was placed in his cage.

The fears of the boy had quadrupled the animal's size, but still for a cobra he was large, being considerably over four feet in length. Having him now at home to practice on, I soon learned how to throw him into this state of temporary lockjaw, and instantly restore him again at pleasure. And besides this, I became certain that the ordinary wounds made by a cobra are nothing compared with his terrible bite when in this strange condition.

Among my collection I had at first six cobras. They used to eat frogs and toads, pursuing them around the room as a dog would a rat, seizing them by whatever part they could catch hold of, and swallowing them down whole and alive. After a time the family increased, for one Saturday night an old lady cobra sur-

prised me by depositing on the dressing table a number of living young ones about as thick as a large cigarette and seven inches long. In these little snakelings the instinct of self-defense was born; for, before they were a minute old, they stood up erect, ready to strike like their parents. They were provided with poison, too, but could not expand their hoods till they were a week older.

Dear, pretty, little venomous babies!—infant criminals of the reptile kind—they had no more knowledge of nor affection for their mamma than if she were an old tree root or something else inanimate lying in their way and troublesome to be climbed over. Nor would the mother take the slightest notice of her interesting family. Indeed, some of them she never saw at all. Most probably she didn't know that they were any relations of hers, or she would have shown them some little attention.

REDONDA AND ITS PHOSPHATES.

By FRED W. MORSE.

REDONDA is a small island lying between Nevis and Montserrat, in that cordon, commonly called the Windward Islands, which keeps the Caribbean Sea apart from the Atlantic Ocean. It was discovered by Columbus, who named it after an old Spanish cathedral instead of a saint, as he did so many of the smaller West Indies. Some authors, however, claim that Redonda means round, and that it was applied because of the domelike appearance of the island.

In the summer of 1890 the writer had the good fortune to spend a week in the company of Prof. Charles H. Hitchcock on the rock—for rock it is and little else. But the rock contains phosphates, which fact explains our visit to such an out-of-the-way place. I call the island out of the way, because, after being invited by Prof. Hitchcock to accompany him there, we could find no account of it, excepting a casual mention in books on the West Indies. From these brief descriptions the opinion was formed that it was an uninhabited and almost inaccessible rock, furnishing a home only for sea birds. We knew that phosphates were mined there, because we had received specimens from cargoes shipped to this country, but those did not enlighten us with regard to the mode of life upon the rock, and it was with some misgivings that we made our arrangements for a midsummer trip to the torrid zone, with the prospect of roughing it under a tropical sun.

The island was reached by taking the steamship Bermuda, which makes the rounds of the Windward Islands, going to Mont-

serrat and there re-embarking in a small sloop which served as the means of communication between Redonda and the outside world. The sloop was chartered by the phosphate company, and made trips, whenever required, to Montserrat and St. Kitts for mails and supplies. The former island is about fourteen miles away and in plain sight, while the latter is thirty miles distant, but it is the nearest cable office.

The Bermuda first touched at St. Kitts, and to reach Montserrat it was necessary to pass within four miles of Redonda, and it was with great interest that we watched for it to appear. Approached from the northwest, it presented the appearance of two rounded hillocks, one much higher and broader than the other. No trees could be seen and no signs of life, but some small white objects on the southwest side near the sea and some more halfway toward the summit were thought to be houses.

A sail of three hours in the sloop carried us from Montserrat to the island, which we reached just as the sun was setting on the last evening in June. Viewed from the south, the larger peak only of the island could be seen, and this gave it a domelike yet one-sided appearance, owing to the western side being steeper than the eastern.

A nearer approach to the island showed that it rose from the sea with vertical walls to the height of several hundred feet, with the highest cliffs on the western side. At the southern end was a plateau, back of which rose the domelike peak. At the foot of the western cliffs was a narrow beach covered with large bowlders fallen from above, and here a small pier projected into the sea. As we approached the pier, a boat manned by two negroes put off to meet us, with a strongly built man with pleasant face and brown beard and dressed in white linen sitting in the stern. The man proved to be Captain H——, the superintendent of the mine, who welcomed us to Redonda and transferred us with our luggage to the shore.

The beach was only a few yards in width, and above us towered the cliffs, over five hundred feet high. Groups of men stood on their brink, looking down at us and appearing like silhouettes against the clear sky. Not far from the wharf the cliffs were broken down by a steep, narrow gorge. The ascent to the plateau above was up this gorge, and was accomplished upon an aërial tramway.

Two stout, heavy wire cables were stretched up the gorge and firmly anchored at both ends. Upon each cable ran a trolley, from which was suspended a large iron bucket. To each trolley was attached the end of a light yet strong wire cable, which passed over a set of heavy pulleys at the top of the cliff, thus causing one bucket to ascend as the other descended. When passengers

or freight were to be raised, the bucket at the top of the cliff was filled with water from a tank, and the lighter load at the bottom was quickly drawn up. The speed was regulated by means of brakes applied to the pulleys.

The main cables were eight hundred feet long, and the load was raised to the height of five hundred and twenty-five feet above the beach. In places the wires ran at a height of sixty feet above the uneven surface of the gorge.

We were invited to get into the bucket which was at the foot. Captain H—— stood upon the edge, clinging to the trolley, and we rapidly glided up between the steep walls of the gorge, from whose rocky sides peered round cactus plants like heads of gnomes and several strange shrubs threw down aërial roots as though in a vain effort to reach the thin soil at the bottom. On gaining the landing at the top we were received by the workmen drawn up in two lines, bowing and murmuring, "Good ebenin, massa," past whom we were conducted up the slope a hundred yards to the superintendent's house. The dwelling and office were really two separate buildings joined together by a wide veranda between them and along their front. This arrangement made them seem like one house in a climate where doors and windows are unnecessary. The buildings had been brought there framed and ready for putting together, and were small cottages with two rooms and with roofs of corrugated iron. We were met at the house by Mrs. H—— and her young daughter Dorothea, who, with the captain, were the sole white inhabitants of the island. A small black boy called Chalmers showed us to our room, where we prepared for dinner. By this time the short twilight of the tropics had been succeeded by darkness, and when we returned to the dining room with its bright light we could hardly believe that we were upon an almost inaccessible rock in the Caribbean Sea.

The next morning, just before daybreak, while yet dark as night in the room, we were awakened by the cries of the sea birds, which made their homes by the hundreds in crevices and niches of the cliffs. Very soon a bell rang in front of the house to awaken the workmen in the huts below us. A tropical dawn is as abrupt as a tropical twilight, and by the time we were dressed and on the veranda the sun was coming up out of the sea and sending its beams in long lines of brightness over the waters.

The trade wind, with its steady, powerful breath, made the morning delightfully cool, and as we stood looking at the sea far below us, as smooth apparently as a lake, it was difficult to realize that it was the middle of summer in the tropics.

The workmen were now filing past the house on their way to the mine at the northern end of the island. The bookkeeper, an intelligent colored man, stood at the corner of the veranda and, as

each man passed, took his name and checked it in a time book. If a workman failed to have his name checked in this manner he forfeited his day's wages.

The early hours of the morning were devoted to an examination of the phosphate mine, under the guidance of Captain H——. The path to the mine led us along the eastern slope of the island to the northern face of the main peak, where a wide and deep ravine separated us from the smaller peak. The distance from the house to the mine was about three fourths of a mile. The path was very steep in places as it ascended toward the summit in order to avoid a deep gorge, and sometimes so narrow that a misstep would give one a bad fall down the slope.

The phosphate occurred in the form of a cement filling the crevices among the masses of volcanic rock of which the island consists. In places it would be in sheets of the thickness of one's finger between the bowlders, and in others pockets would be filled with several tons. It could be seen cropping out all along the path, but the mining was at that time carried on at the north end for convenience in shipping.

The mining was done by negroes, and both men and boys were employed in the work. The men were engaged in blasting the overlying rock and breaking up the mass of phosphate underneath, while the boys cleaned the phosphate from the gangue and carried it in baskets upon their heads to a wire tramway, by which it was taken to the pile of dressed mineral awaiting shipment. Boys were also engaged in picking out the mineral from small surface pockets wherever a few pounds might be obtained.

The gangue was thrown down the gorge between the two peaks into the sea. While we were there a large bowlder was rolled over for our benefit. It went bounding from ledge to ledge, leaping a hundred feet at a bound, shot over a precipice and struck upon a rock with a loud report, finally splashing into the water. Great quantities of dust were formed by the blasting and digging, and caused much discomfort to the workmen by particles of it getting into their eyes.

The cleaned rock was piled at the head of a gorge which had been broken through the cliffs on the northwestern side of the island. Down this gorge and extending out about fifty yards into the sea was stretched another wire tramway, twelve hundred feet in length, by which the phosphate was loaded into lighters to be transferred from the shore to the ship. The usual anchorage was on the leeward or western side of the island, about four hundred yards from the shore, though deep water extended to within fifty yards of the cliffs.

The phosphate differed in its appearance from any other rock phosphate which I have ever seen. The prevailing color of a pile

of dressed mineral was grayish brown, but many lumps were observed of chocolate and ferruginous shades, and many more mottled and streaked with all three; the light-colored variety sometimes shaded to milk-white. The appearance was generally earthy, except with the white variety, which was translucent and resembled flint or opal. The structure was partially oölitic, with many minute cavities, which were usually lined with a white coating. The grayish-brown and chocolate varieties were also frequently amygdaloidal, and the latter kind yielded a few specimens which were beautifully inlaid with ovoidal forms as large as coffee grains, of a lighter brown than the surrounding mass. Most of the phosphate was amorphous; but occasionally the surfaces of hollows or cavities in the pockets and of crevices or seams in the gangue would be covered with the opal-like variety in botryoidal forms of varying sizes, from that of a mustard seed to that of a currant.

The composition of the mineral is that of a hydrated phosphate of aluminum and iron, with a variable amount of silica and other insoluble matter. The commercial article was guaranteed to contain thirty-five per cent of phosphoric anhydride, while the purest specimens yielded about forty-two per cent. Scarcely more than a trace of lime has been found in any specimen.

By the time at which we had concluded our examination of the mine the sun had become very hot, and we returned to the house, where we spent the middle of the day in the shade of the veranda. Perched up there, six hundred feet above the sea, with the water almost beneath us, we enjoyed a view as novel as it was interesting. The air seemed cool, although out on the rocks the heat was scorching in its intensity. The sea, so far below us, looked like a lake just rippled by the breeze. To the east could be seen the low, cloudlike outline of Antigua. Directly in front of us, to the south, lay Montserrat, its nearest headland seeming but a few miles away, and having a white ledge near the sea which resembled the sail of a sloop rounding the point. Once a cloud spun down from the sky in the form of a funnel, and, touching the sea, formed for an instant a waterspout, but there was not enough volume to last. A steamship plowed its way toward Montserrat, and to us, in our rocky eyrie, appeared like a toy. The sea was the same, and yet different every minute.

On the rocks about the house were also objects to attract the attention. Lizards, both brown and green, ran over the ledges and among the cactus, which grew in large masses on the slope below the veranda, while above them might almost always be seen a tiny hawk hovering in the air, looking very much like a martin with its dark-blue back and white belly, but betraying its identity by its movements. Bright green humming birds poised them-

selves before the red and yellow blossoms of the cactus, and a little insect-eater, in sober brown with a ruby patch on its head, searched busily among the plants.

Several sheep and goats, two dogs, some hens, two peacocks, and a white cat comprised the domestic animals of this Crusoe-like home. From time to time the sheep and goats had become wild and had taken to the almost inaccessible parts of the cliffs and gorges, where it was exciting sport to pursue them.

After lunch, when the sun had begun to descend toward the west, Captain H—— took us down to the plateau below the house to look at the quarters occupied by the workmen. The buildings consisted of two long sheds with close shutters instead of glass windows, and contained for furniture nothing but a tier of bunks, or rather shelves, of rough boards along the walls. Each man furnished his own bedding, which was seldom more than a rude cushion for a pillow. This pillow, together with his other personal belongings, he kept in a box which served him for a trunk.

Near the buildings were ovens where their baking was done by one of their number who served as cook. Their fare was very simple, consisting of bread and salt beef. The foremen and skilled workmen occupied two smaller houses, but lived in the same manner. Water for drinking was obtained by catching the rain on large inclined surfaces of corrugated iron, and collecting it in reservoirs. Such a reservoir was built at each end of the island for the use of the men, and the superintendent's dwelling was provided with capacious tanks connected with the roof.

We were on Redonda just at the time of the full moon, and there was something about the beauty of a moonlight night on that rock which can not be put in words. The sea sparkled with silver gleams as we looked down upon it. Montserrat's rugged outline could be dimly seen, with lights twinkling here and there on its hillsides. Below us the workmen could be heard singing and dancing to the sound of a tambourine. After the hot glare of the daytime everything seemed to be enjoying the delightful coolness of the trade wind. Indeed, so cool was it that it caused me great surprise to find the thermometer registering seventy-eight degrees.

The second morning we descended to the beach by means of the tramway, and at Captain H——'s suggestion I stood upon the edge of the bucket and clung to the trolley. It was exhilarating to glide swiftly down through space, with the cliffs close beside us and the beach far below, yet it was with a breath of relief that I sprang from the bucket to the ground when we had reached the end of the wire.

For a distance of about fifty yards the beach had been cleared of bowlders, and room thus secured for two or three small build-

ings, the pier, and woodpile. The wood was all brought from Montserrat aboard the sloop. An engine and pump raised water from the sea to the cliffs above, to serve as ballast for the buckets of the tramway whenever passengers or goods were to be taken up.

Entering a boat manned by two negroes, we were rowed along the western side of the island from one end to the other. The cliffs on this side showed a beautiful system of stratification, consisting of alternate layers of solid trap rock and coarse volcanic sand extending from the sea up the whole face. These strata were not horizontal, but in the form of broad arches, the largest of which could only be compared to the rainbow for magnificence of extent. In one place was to be seen a fault, where the upward pressure which formed the arches had caused one to break and the trap rock had been forced upward through three other strata. At the southwest side of the island the sea was gradually washing out the lowest stratum of sand, leaving low arched caverns like the entrances to vaults.

At several points about the island masses of rock resembling the pinnacles and buttresses of a Gothic cathedral appeared to have been thrust up by the upheaval which had caused the bending of the strata. Rude, arched openings extended into them or through them, and one cavern at the north end, nearly forty feet in height, seemed the portal to the very center of the rock. The sea dashed into this opening with a loud noise, and, as an unusually large wave thundered against the innermost walls, a jet of water gushed outward from a small blow-hole in the western cliff, about forty yards from the mouth of the cavern and at a man's height above the sea.

The colors of the cliffs were various shades of gray and ferruginous. The smaller of the two peaks was of a light ferruginous, while the main peak was grayish white.

Perched upon the rocks, and sitting in rows along the gunwales of the lighters, were hundreds of birds. Terns were the most numerous, and were apparently limited to two species which congregated in different parts of the cliff. A black and white species chose the western side, while a blue species, resembling in color a blue pigeon, built its nests on the southern. The nests were mere bunches of grass and feathers, and were so carèlessly placed on the shelves of rock that both eggs and young were often found on the beach. Ducks with black bodies and white heads were plentiful, and frigate birds with wide-spreading wings sailed overhead, reminding me of our osprey or fishhawk.

The sea around Redonda was very clear, and Captain H—— gave us an opportunity to look through a water glass. The instrument consisted of a long, narrow box, open at one end, and

closed at the other by a piece of plain glass. The box was slung over the side of the boat, with the glass end submerged; and on putting one's face at the open end a new world was revealed below the surface. From two to five fathoms below us the rocks were covered with sponges and corals, and strange fishes swam calmly among them. One large fish was a beautiful creation of purple and silver, and there were many of the red and gold fish so often seen in an aquarium. These latter were the principal food fish of the region. The anchors and chains to which the tram wires were moored were covered with a dense growth of seaweed, which looked very pretty in the sunlight streaming down through the water.

The third day was spent upon the eastern side of the island and upon the summit. Two gorges ran down the slope, beginning nearly at the top. One was covered over much of its surface with fragments of whitish rock, and ended in a cliff a hundred feet in height. The other was the widest and steepest gorge about the island, and extended to the sea; however, it was impracticable of ascent, because of its steepness and its situation on the windward side of the island. The sea was steadily carving away the slope, and had made a deep bay with cliffs on either side three hundred feet high.

The climb from the cliffs at the edge of the island to the summit was very fatiguing on account of the steep ascent. In shaded spots among the rocks beautiful gold and silver ferns grew abundantly, and there were occasional holes where rain had settled which afforded water for the wild goats and sheep. Almost at the summit was the remnant of a deposit of guano. The deposit was never a large one, but it led to the discovery of the mineral phosphate. A few air plants, a species of *Tillandsia*, clung to the projections of the rocks and formed almost the sole vegetation at the extreme summit. The apex did not consist of a solid mass of rock, but was a pile of huge bowlders without the phosphatic cement of the lower slopes. Looking down the almost vertical western wall, it seemed as though one could leap into the sea one thousand feet below. From this point could be seen Nevis, to the north and near by; while in the distance was St. Kitts with its cloud-capped Mount Misery.

One of the drawbacks to exploring the island was a variety of cactus which the workmen spoke of as "suckers." It resembled the prickly pear in form and had a yellow blossom. Its joints or sections were thickly covered with thorns or spines, which were from three fourths of an inch to an inch and a half in length and barbed at the tip. The joints were easily broken off, and clung to anything upon which their spines could catch. The animals about the place were almost always seen with from one

to a half dozen of these "suckers" clinging to them. When a barbed spine became imbedded in the flesh it produced a sore unless removed at once, and it was usually necessary to cut it out in order to remove it. The phosphatic soil and hot sun seemed peculiarly fitted to its growth, and it formed the principal vegetation of the eastern slope. Ordinary domesticated plants of the temperate zone rushed to a speedy maturity under the same conditions.

The remainder of our stay was spent in collecting and preparing specimens of the phosphate, and also of the plants and animals. The negroes brought us many lizards and some big land crabs, and were especially requested to procure us some centipeds and an iguana which were said to be occasionally seen among the rocks. They failed, however, to bring us any during our stay, though subsequently an iguana was sent to Prof. Hitchcock by Captain H——.

The glorious Fourth came while we were there, and Captain H—— favored us in the evening with a display of signal fires and rockets. The compliment was highly appreciated by us, and also by the workmen, who sent up a vigorous shout from their quarters below as each rocket went off.

On Sunday morning, after breakfast, the workmen were summoned by the bell to meet in front of the house and answer to their names. In order to have better control over his men, Captain H—— had devised the arrangement of dividing a man's weekly wages into seven portions instead of six, and obliging him to report at roll call on Sunday or forfeit his weekly earnings. This method put them on their good behavior during this day as well as the others, whereas they had previously claimed Sunday as their own in which to do as they pleased. It was an interesting sight to see the line of black faces, varying in intelligence from refinement to brutishness. The foremen and skilled workmen were dressed in neat white shirts and trousers, serge or linen coats, and polished shoes, and had bright, strong features. Nearly all the men had changed their working garb of shirt and overalls for clean shirts and trousers, and had their usually bare feet covered with shoes, to which they seemed painfully unaccustomed.

As the roll was called I was astonished to hear the names Michael and Patrick coupled with Sweeny and Burke, names very familiar to my ears, but there responded to by men with shining, ebony faces. On inquiry I learned that these men belonged in Montserrat, which was settled over a century ago by Irish refugees, whose family names had descended through their slaves to these miners.

The men were mostly procured from Montserrat and St. Martin's, and were engaged for a term of three months, at the expira-

tion of which they were at liberty to go home if they chose, or were discharged if no longer needed.

On that Sunday there were one hundred and one people on the island, of whom five only were white. However, this proportion of black to white was no greater than in the neighboring islands.

In the afternoon, while taking a nap, I was awakened by what I vaguely thought to be the thunder of a coming storm; but it proved to be Chalmers trying to drive a goat off the iron roof, to which it had sprung from the steep incline behind the house. Though it was now the beginning of the hurricane season, the weather was calm and fine during our whole stay in the tropics.

On Monday the brigantine Foley arrived for a cargo of phosphate, and we went to the lookout west of the house to see her drop anchor. We were at least six hundred feet above the sea, and as the vessel lay in the shelter of the cliff she looked like a boy's ship floating on a pond. The wind was blowing briskly at the time, but the island afforded a perfect shelter against it, and the calm area could be seen extending like a shadow over the sea for half a mile. This protection from the wind also caused it to be almost unbearably hot down on the beach in the afternoon sun, which was reflected from water and cliffs.

On Tuesday, July 8th, we bade good-by to Mrs. H—— and Miss Dorothea, and descended the wires for the last time. Captain H—— went with us aboard the sloop which was to take us to Montserrat. We were soon on our way, and the ensign of Great Britain, flying in front of the house, was dipped three times. We waved a final adieu, and the lofty walls of Redonda were thereafter seen by us only from a distance.

Mr. Jacques W. Redway expresses the opinion in the Geographical Journal that the reason why the prairies and plains of the United States are treeless, is because they have never been seeded with trees, and this because they have never been exposed to inundations from tree-bearing districts. "Water," he says, "has been the chief agent in the distribution of trees, and the treeless regions are the greater part in regions that have not been disturbed by physiographic agencies. From the southern limit of glaciation to the made lands along the coast of the Gulf of Mexico, the central plain of the United States is the level bed of a Palæozoic sea. Excepting such places where the streams of Champlain times have cut channels through the upper strata, the surface of this vast plain is undisturbed; it is at once a sedentary soil of Silurian disintegrations and a Quaternary epoch. Throughout much of its extent it is treeless, not because of prairie fires, nor yet of unwholesome conditions of the soil, but from the simple fact that the seeds of forest trees have never been distributed over its surface at fortuitous times. Prairie fires have doubtless had more or less to do with retarding the distribution of forestry; so undoubtedly have unwholesome conditions of the soil. Neither condition, however, is sufficiently potent to prevent the *emboisment* (tree-clothing) of a treeless area; it is still less able to deforest a timbered area."

THE SIOUX MYTHOLOGY.

By Dr. CHARLES A. EASTMAN.

THE tendency of the uncivilized and untutored mind is to recognize the Deity through some visible medium. The soul has an inborn consciousness of the highest good or *God*. The aborigines of our country illustrate this truth. I wish to write of the mythology of the Sioux nation, more particularly that portion of the tribe dwelling east of the Missouri River, with which I am very familiar, although the others are not distinctively different in their religious customs.

The human mind, equipped with all its faculties, is capable even in an uncultured state of a logical process of reasoning. Freed from the burdensome theories of science and theology, it is impressed powerfully by God's omnipresence, omniscience, and omnipotence. Alexander Pope's worn-out lines—

> "Lo, the poor Indian! whose untutored mind
> Sees God in clouds and hears him in the wind"—

are true, in that the Indian recognized a power behind every natural force. He saw God, not only in the sky, but in every creation. All Nature sang his praises—birds, waterfalls, tree tops—everything whispered the name of the mysterious God.

The Indian did not trouble himself concerning the nature of the Creator. He was satisfied that there was a God, whose laws all must obey, and whom he blindly or instinctively worshiped as the "Great Mystery."

The relation between God and man he conceived from the analogy of Nature. His God is a gracious yet an exacting parent. He punishes both the disobedient and the evil-doer, and forgives and helps the penitent and the good. He hears prayers. He is called *Wakantanka*, or the Great Mystery. The word *wakan* means mystery or holy, and *tanka* means great, mighty, or supreme. Neither of the two words signifies *spirit;* however, it may imply that. The word *wakan* may also mean reverenced or sacred.

Before the coming of the missionaries the Sioux never prayed or gave any offering direct to God, except at a great feast once a year. It was believed that he was too great to be approached directly, but that a prayer or a gift through some of his attributes would reach him. The legend is that God occasionally descends to earth in the shape of some animal, or envelops himself in a great wind. If any person beholds his face he dies instantly, although the same person may be born again as a child and become a great "medicine man."

Before the advent of the white man these people believed that the earth was flat, with a circular form, and was suspended in a dark space, and sheltered by the heaven or sky in the shape of a hollow hemisphere. The sun was regarded as the father and the earth the mother of all things that live and grow; but as they had been married a long time and had become the parents of many generations, they were called the great-grandparents. As far as I can judge, the moon seemed to be their servant; at least, she was required to watch, together with her brothers, the stars, over the sleeping universe, while the sun came down to rest with his family.

In the thunder-bird they believed God had a warrior who presided over the most powerful elements—the storm and the fearful cyclone. This symbolic creature is depicted as an impatient and wrathy god of war, at whose appearance even the ever-smiling grandfather, the sun, hides his face. In the realms of water the whale is the symbolized chief of the finny tribes. In every great lake the Sioux imagines a huge fish as ruler of its waters.

Yet none of these possess the power of speech. The Great Mystery had shown them some truths denied to man, but he did not trust them fully, therefore he made them dumb. They can only show to man some supernatural things by signs or in dreams; as, for instance, to foretell future events or explain the use of certain powerful remedies. The savage holds that the key of heaven is vested in the visible phenomena of the universe. All creatures, save man, are assigned to a peculiar paradise, in which there is a forbidden fruit—namely, the apple of speech and reasoning. Hence the animals and inanimate things are exempted from sin. Thus it is that rocks, trees, and rivers are surrounded with an atmosphere of grandeur, beauty, and mystery. Nature is the interpreter of the Great Mystery, and through her man is convinced of truth.

The root-eating animals were believed to be intrusted with the mysteries of medicine. They were the medicine-givers. The sun and the thunder-bird also possessed efficacious treatments, but without the use of roots and herbs. On account of these beliefs the practices of no two medicine men among the Sioux are exactly the same. Each claims that his knowledge of medicine was obtained from some particular animal, of whom the bear, beaver, etc., are first in the profession. Those who found their treatment upon the power of the sun or the thunder-bird do not use any medicine. There was but one general organization among the Sioux, and this was based upon medicine and religion combined. It was called the "Holy Medicine Lodges." There were many of these lodges, each one different in its medicines and medicine songs, but alike in all other respects. They had a com-

mon form of initiation. It was effected publicly at a union meeting of all the lodges. Whenever a member of one of the lodges died, a candidate was introduced, and he was instructed by a select committee of experienced and pure men, according to the savage notion.

The novice must bear in mind that purity and feast making are the foundations of the lodge, and pleasing to the Great Mystery. "Thou shalt often make a holy feast or a lodge feast to the God. Thou shalt not spill the blood of any of thy tribe. Thou shalt not steal what belongs to another. Thou shalt always remember that the choicest part of thy provision belongs to God." These were some of their commandments. It is a peculiar fact, already mentioned, that the Great Mystery was never directly approached except upon special and extraordinary occasions, such as the union meeting and dance of the "medicine lodges" once a year. Then a chosen priest usually made a prayer to the Supreme Being. The material rewards of a godly life were looked for in the immediate future; and yet there was a feeling of satisfaction in the savage bosom that God was pleased with his efforts.

The spirits of the departed Sioux were, it was supposed, admitted at once into the mysteries of God, except those of the very wicked, who were returned to this world in the form of one of the lower animals. This was their punishment. Yet such a spirit might retrieve its misfortune by good behavior, and thus be promoted to its former shape.

In man there were believed to be three souls. One of these, as I have said, immediately enters heaven by the "spirits' path"—the milky way—escorted by the stars. The second remains where the body is placed, as guardian of the grave; while the third lives and travels with its relatives. On this account the natives believe that everything said of the departed is heard by them. I do not know just how this triune conception originated. No doubt it had a reasonable explanation somewhere in the early life of the race, but the legend connected with it is lost.

There is a strong implication that the Great Mystery has made man after himself, and that he is in shape like a man, but with a few modifications. For instance, he is supposed to have horns, symbolic of command; and his eyes are like the sun—no one can gaze into them. The Sioux formerly believed that every created thing can hear what is said of the Creator. Therefore, an Indian fears to take God's name in vain, and there is no profane word in their language. Whenever God's name is used it is done with reverence. In this connection I may be permitted to add that when the Indian found that his white brothers used the name of God indiscriminately and irreverently he was shocked.

It was further observed by him that, inasmuch as there are pairs or opposites in all things, there is a good and an evil spirit; yet both of these are appointed and controlled by the Great Mystery. There were no angels in the Indian's theology. As there is a spirit of antagonism among animals, so also the Indian believed that the elements do often wage war upon each other, and sometimes upon the animals. For instance, it was supposed that the thunder-bird often goes upon the warpath, traveling over vast tracts of country and chastising both animate and inanimate things.

SOME ANALOGIES AND HOMOLOGIES.

By W. T. FREEMAN, F. R. C. S.

READERS nowadays like to have things made easy for them. The student has worked for year after year at one new subject after the other; it has been hard work for him, he has painfully struggled to master the new facts, the new ideas, and the time comes when he has reached the acme of his work; he thinks more for himself, reads magazines more than books, and prefers to digest the articles in his armchair, and they must be put for him in an appetizing form, must reach him in fact as the old ideas amplified and reclothed. Very pleasant reading the old lore brought home again, very refreshing to regain what is nearly lost by the help of a few chatty words in every-day tones; nice to dream, even among the words of the scientist, and to drift into illusive paths of speculation which are pointing dimly through and away beyond the veil of thought. May this little paper then be simply a series of dips here and there into the teachings of the unity of type and ideas, leaving the workings of the deeper mines for those who are fit for the labor.

Analogues and homologues are words with a practical ring about them, but they can not always be dealt with in a practical manner. The analogies of the creation teach us that everything is spun of the same stuff and upon one plan. Let a powerful example of this fact be taken in hand at once, and some portion of the animal creation be utilized. Now, we have all of us necks, some of us graceful necks, some of us apoplectic necks, and some of us no necks at all to speak of; again, the giraffe has a very long neck, the elephant a very short one, and the porpoise apparently stops short of one altogether, but in each and every case we find seven cervical vertebræ—*and seven only.* Again, they, and human beings also, all have the same number and variety of muscles and ligaments. Some of them certainly are simply mere representatives; for instance, the powerful ligamentum nuchæ of the horse

is but very feebly represented in man. "Padding" accounts for all the rest—a little more or less of fat and cellular tissue.

> "Every face however full,
> Padded round with flesh and fat,
> Is but modeled on a skull,"

and it tells the same tale of the rest of the figure. It seems an odd statement at first sight, but there are many millions of beings who have an outside instead of an inside skeleton. What a miserable existence these poor creatures must have if they have a good figure, for it can not be exhibited! The lobster is of the 40-exoskeleton type.

I have dealt with necks, now for the other extreme. It might be argued that one great difference between ourselves and the rest of the vertebrates is marked by the fact of our having no tail. We all have tails. 'Tis true they are wretched specimens, but they exist universally. We do not wag our tails, but only the other day I spoke with a gentleman who had a dog whose caudal vertebræ were anchylosed together. A little careful selection with this dog, and it is probable that a race of dogs might be developed with an os coccygis like ourselves. Disuse invariably leads to abortion. The little mass of anchylosed vertebræ that we call the os coccyx is our best apology for a tail, but this region of the spinal column becomes wonderfully modified and developed if we compare it with its homologue in other members of the creation. It may act as a hand, may be the exclusive locomotive organ, it may contain the only free vertebræ in the body. In the spider monkey it is prehensile and is often used as a hand. In some sharks the number of the vertebræ amounts to two hundred and seventy. In tortoises the coccygeal vertebræ are the only free vertebræ. In the sole the neural spines and the hypophyses are remarkably developed. Finally, the bone may be even more rudimentary than in man. In the bat there are but two coccygeal vertebræ.

Quite a developed tail has, says Marshall, been discovered in the human race in certain rare and anomalous cases.

In the embryonic stage of the vertebrates the spinal column is represented by the so-called notochord, *and this notochord is temporarily represented in the Ascidians, a class of animals bearing not the remotest resemblance to the Vertebrates.* This is a highly interesting fact in connection with the interrelation of species.

One other most interesting fact: *At an early period of our development—that is to say, at an early part of our embryo existence—the os coccyx is free and projects beyond the lower extremities.*

One other less interesting fact: What tail we have is always carried between our legs—no doubt, in the majority of instances, there is good reason for it!

Our limbs form beautiful subjects for comparison. Throughout the vertebrates they never exceed four in number. They are all modifications of one type, whether we take the fins of fish, the wings and legs of birds, fore and hind legs of quadrupeds, or arms and legs of man. Comparing the leg of a bird with the leg of a man, we see that the complete leg of a bird shows first the thigh bone, then the tibia or lower leg bone, and then in the place of the tarsus and metatarsus a single bone, with, at its lower extremity, a small bone supporting the four toes. Primarily the analogy between the last five bones of the bird and the so-called tarsus, metatarsus, and toes of man does not seem very complete, but if the chick in the egg be examined, its leg will be found to consist of the thigh bone, of the tibia, of two tarsal and three or four metatarsal bones, and the toes or phalanges. The upper tarsal bone subsequently becomes anchylosed with the tibia and the lower one with the consolidated metatarsus. Now the analogy becomes much more complete.

The horse has but a single metatarsal bone (the third), with rudiments of the second and fourth. These rudimentary metatarsal bones of the horse are very interesting. By means of them it is comparatively easy to trace out his descent. I may be pardoned for mentioning such well-known facts and analogies as the following, among the vertebrata—that the whale possesses the rudiments of hind legs, that the boa constrictor possesses also the rudiments of a leg and a pelvis, and that the rudiments of the wings are discoverable in the apteryx.

A few other animal analogies: The third eyelid of the bird exists also in some amphibians and reptiles and in sharks; also in man as a rudimentary structure.

The manner in which cows, deer, and sheep tear up the grass when they are feeding, plucking away at the tufts, is familiar to any observant man. The incisors of the upper teeth are wanting. The interesting analogy is the fact that the teeth are really there, but they are uncut—that is to say, they have never pierced the gum.

The skin with its appendages forms a beautiful story of analogy. Our own microscopical epidermic scales are strictly comparable with the cells that make up the scales of fish and of reptiles; their further development into hairs and nails again compares with the feathers of birds and the hoofs and horns of animals.

We call ourselves a hairless race, but everywhere on our bodies are the small lanugo hairs. Stimulation will readily cause these hairs to grow to any extent. The surgeon has frequent opportunities of witnessing this retrograde progression toward a lower type.

Molting has its analogy throughout the animal kingdom. We

indeed molt invisibly, are continuously shedding our scales, but there are some animals that get through this process even more quickly than do birds, as, for instance, the shedding of the skin as a whole by the newt, eft, and snake.

Sir James Paget has noted that some people have a few extra long hairs growing out from the general mass of the eyebrows. These few long hairs are representatives of a permanent condition in the chimpanzee and some baboons. They grow out separately from the general hairy mass over the superciliary ridges.

Darwin notes as a significant fact that the palms of the hands and the soles of the feet of man are quite naked of hairs, like the inferior surfaces of all four extremities in most of the lower animals.

Something about the ear. The lobule of the ear is peculiar to man: there is, however, a rudiment of it in the gorilla. Happy gorilla—and man!

About the brain of man and apes. The whole comparison is one of degree, and in the case of the Bushman's brain with that of a well-developed ape, the comparison becomes nearly equal. Richard Owen once claimed that the hippocampus minor, a trifling portion of the interior of the brain, was the only exclusively characteristic human part, but it has since been demonstrated in the orang and chimpanzee. In truth there are no specific distinctions between the brain of the ape and that of man! I possess in pickle the brain of a monkey; I am sure that my own brain is of much greater proportional weight and complexity. It is a pleasing reflection!

To turn to a totally different class of analogies, picking them out and noting them from the thousands of examples in the world of manners, thoughts, and ideas. The effects of civilization and town life upon man and some of the lower creation is very well exemplified by the town sparrow being seldom caught by a cat or slain by a missile, while the bumpkin bird is easily overtaken by the one or the other. *Experientia docet*—at one time the gulls of the Serpentine used to slay the sparrows; they knew not their enemy, but with each new generation of their victims the gulls had fewer meals. Instinct has been described as the accumulated experience of the race. We have had a good example of it here; that it is common enough among the different races of mankind and the various animals of the creation goes without saying, and Dr. Taylor nearly proves that it exists among plants.

Parents watching the characters of their children observe that at one time the traits of the mother are to the fore, and that at another period of the child's existence he or she shows the chips

of the old block by exhibiting some mannerism or peculiarity of the father. Apparently the male points are as easily inherited as the female points, and most certainly when the male tendencies are most evident, then the female tendencies are more or less in abeyance, and *vice versa*, and these variabilities may of course occur at any period of the being's existence, often, alas! when least desired. It has been disputed whether the female points of a plant are not more readily inherited than the male. A few years ago it was stated that the chances were as much as three to one in favor of the female side. Messrs. Sutton's foreman has experimented on these lines, particularly with wild potatoes and a cross with gloxinias. He seems convinced that the hereditary traits of the male are shown as often and as decisively as those of the female. But he is also convinced that, while the staminal tendencies are to the fore, the pistillate tendencies are more or less in abeyance. For a considerable period of the plant's growth he has noted nothing but the male tendencies; suddenly the whole bearings of the plant have changed, the staminal tendencies have absolutely died off, and a plant with all the traits of its mother rapidly shows up in its place.

The reasons why a plant should always be called a plant, and an animal an animal, are not always very apparent. An animal is a conscious being. I mean that it knows how to discriminate between this and that, reasons about what is good for it, rejects what experience has informed it is not good for it, and has special sences. It is a conscious being—indeed reasons, discriminates. Here is a great gulf between the animal and the plant! Most of us are ready to acknowledge such simple truths, and we are all wrong, for the differences when sifted are only those of a greater and lesser degree. Some plants like shade, some like light. Why? Well, why do we under some circumstances prefer dark, and under others light? When we are healthy we can digest meat, and reject, with good reason, a meal of sticks and stones. A carnivorous plant receives and digests a proportionate meat meal, but feed it with pebbles and bits of stick, and it refuses to receive such dainties. We bend beneath a blow, we protect ourselves from further injuries that we judge may follow—so do the sensitive plants. With the aid of a specialist in this class of work I am trying to demonstrate the presence of nervous tissue in plants. So far, we have not been successful, but the circumstantial evidence is so strong that we may feel quite certain that better methods of demonstration will give ocular evidence of what we seek. The proofs of the struggle for existence in both animal and plant life have been prettily told by Taylor.

The part that color and get-up plays in the propagation of species is precisely analogous, alike in the doings of man, the

lower animals, and plants. This I have more thoroughly touched upon in a previous paper.*

The perfumes attached to plants and the animate creation are in both instances used for like purposes, generally to attract, sometimes to repel.

The feasting and temporary entrapping of the flies within the spathe of the arum until the pollen has been dusted upon their backs for distribution, have been compared to the feasting of the old-day voters at the candidate's expense.

The intermarriage of near relatives, or the interbreeding among home flocks, is most disastrous in its effect upon the offspring. Plant life appears to be aware of all this, and adopts the most startling devices for its confutation. Some of these devices are worth tabulating:

I. Staminate flowers, pistillate flowers—these may be monœcious or diœcious.

II. Pistils elevated above the stamens.

III. Pistils arranged at different heights, as in the pin-eyed and rose-eyed roses.

IV. Different sizes and lengths of both stamens and pistils, as in the purple loosestrife.

V. Their own pollen acts injuriously to the pistils of some flowers, as in the primroses.

VI. Most startling observation of all—the pistil is cleft and the two stigmatic portions are maintained closed until the pollen of the flower is removed—as in the salvias.

VII. The catkins of the oak are beautiful devices for the winds of spring to scatter the pollen.

VIII. The facts collected by Darwin in the natural history of orchids.

IX. The milkweeds are said to be able to discriminate between those insects that will be able to cross them and those that will not. Their vengeance upon the useless intruder is indeed vindictive—they seize upon and hold him till he dies.

X. The stamens and pistils do not always ripen at the same time.

XI. In order to save their own increase and insure crossing, some flowers denote to insects an absence of honey by a change in the color of their petals.

An observant gardener informs me that races of plants improve and improve by proper cultivation and care until they reach their zenith. The zenith being reached, the greatest care is necessary, lest the decline should begin; but, with the necessary amount of care, the height of their prosperity may be prolonged indefinitely, but once the decline begins, the fall to probable extinction has inevitably commenced. How well may this be likened to the career of nations! Internal dissensions and the agitator's wile may ruin the backbone and trade of a country, and hasten on its fall. The noble and broad-minded statesman is the conscientious

* See Something about Natural Selection, Gentleman's Magazine, August, 1892.

and hard-working gardener striving to outwit the enemies and parasites of his time, saving and enwreathing his cares in the glory of the achievements of the past.

The animal moves—most gifted and superior animal that possesses a power which the plant does not! Is this a truism? Among many kinds of fungi, water-weeds, sea-weeds, mosses, and even ferns, the spores and male organs actually possess locomotive power, and by means of cilia and flagella are able to move from the parent plant, and distribute themselves to some distance.

The suicidal mania is apparently appreciated by not man only. In Africa, ants have been seen marching by thousands for days together into a stream, and being swallowed by crowds of fish as fast as they could get into the water. Butterflies have been known to migrate in numbers to the sea. Similar tales have been told of rats.

We say that the existence and possession of a soul, the something that dogmatic theology asserts can exist after the death of the brain, after the death of the individual, is the attribute of man alone, and marks him as the head of the creation. Every thought that passes through our mind, every effort that guides our pen, is brought about by the molecular energy of the brain and of the muscle cells; this power is dependent upon the proper nutrition of these cells and of the body as a whole. Starve the tissues of the brain and muscle—thought no longer flows, the pen is no longer guided. The lower animals think, move, have instinct; they are conscious of ill or wrong, of joy and remorse, and herein lie the totalities of the soul. Soul is only the name for a mystery that we can not explain, and this mysterious combination which leads us to dwell upon a life devoid of mechanism, a life freed from the trammels of matter, with its repellent forces and energies, surely belongs to us only in degree. What rights have we, what proofs have we, to help us to assume to ourselves a one exclusive evolving soul, fitting itself for a newer and purer existence, and yet to deny all that we base our hopes upon to the whole of the rest of the creation? Surely the lower animals have their degree of soul, and a chance of a lesser heaven as well as our important selves. Our thoughts and actions are bestial, only too often to a loathsome degree; and on the other hand not only the ape world, but also still lower creatures, point us daily many a useful moral or loving lesson. Does the existence of the soul mark the gulf that separates man from all other living beings? Does the lowest Bushman of to-day possess a soul denied to the highest anthropoid ape, and if he does not, who shall draw the line where the animal is separated from beatified man?—not man, at all events.

In the frightful and only too common form of insanity, "the

general paralysis of the insane," at different periods the actions and behavior of the unfortunate patient become horribly monkey-like. The continuous chattering, the restless clawing movements, and the stage at which the food is seized and crammed into the mouth, and, too, the half-childish, half-monkey-like gibes and smiles which wreath the poor wretch's features as he pours his grandiose ideas into the listeners' ears, create a sickening impression for the observer to think upon.

A little more old lore concerning apes and man, including a little recapitulation.

Man compares with the anthropomorphous apes in that the relative weight of a Bushman's brain compared with that, say, of an ordinary gorilla is only as three to two. The furrows and convolutions are really the same in both, and the ape does possess a hippocampus minor. The anthropomorphous apes possess, as do men, five molars; this of course includes the bicuspids with the molars. Even a prehensile toe is not unknown as a human attribute—i. e., the tendency to oppose the big toe to the others. In the gorilla especially the contrast between hand and foot is nearly as distinct as in man. Then again there is the discoidal placenta with, as in the chimpanzee, its two umbilical arteries and one umbilical vein. It is to be noted that the anthropomorphous apes differ far more from the lower apes than do they from man. Lucia and others have said much regarding the fact that the ape as he grows becomes more bestial, and man more human.

Man's descent from the ape is not direct; apart from this, the laws of heredity forbid the retrogression of the one species to any great extent, or the exaltment of the other. Man's kinship, however, is not upset by the bestial strength of the teeth of the ape, or by the enormous protuberances on the skulls of this animal. The embryonic and youthful skull of the ape exhibits a plastic and well-formed cranium. Later, in form and character, it strikes out into a divergent and disastrous path.

Two of the supposed great distinctive marks of division between plants and animals are now disproved. Cellulose was believed to be found alone in vegetable tissue, but now starch, chlorophyll, and cellulose are known to occur in the lower types of the animal kingdom. Animals were supposed to subsist only upon ready-made organic material, while plants were known to be able to convert inorganic into organic material. This partition wall has also been overthrown.

Stinging and prickly plants may be fairly said to possess and use weapons of defense. The sensitive plant, too, in a timid manner resists to the last the attacks of its attackers, and I am convinced that it appreciates the current from an electric machine. I have tried to reason with myself that my observations have

been fanciful, and have been forced to the conclusion that these plants possess not only nervous ganglionic centers in their leaves, but cords of communication running even to the stem, where possibly there may be the rudiments of a spinal cord communicating, may be, with other ganglia in the roots, the totality of which would represent a brain. Nuclei and tracts of special sensations (unless they be special plant sensations), apparently, they do not possess—I mean such sensations as sight and hearing. They are, to some extent, sensitive to a breath of wind when no actual contact takes place.

Men are wise in their generation—the wisdon of man is indeed a remarkable trait of the creature—but the weather wisdom and the immigration wisdom of birds are traits equally remarkable. If the bird lore is due to the accumulated experience of the race, just so much can be said also about the wisdom of man.

Man loves alcohol; man includes the teetotaler who loves alcohol also, but who most wisely refrains, as he doubts his own powers of resistance to excess. Here, possibly, there is a gulf between man and the lower animals. The lower creatures, as far as I know, never refrain from alcohol in excess, if they can get it. Many tales have been told of alcoholism in the lower animals, none of moderate drinking, if the alcohol were available; therefore, perhaps, the only great difference between man and the lower animals is that man may be a moderate alcoholist. Monkeys are peculiarly fond of arrack and such stuff. Possibly, therefore, our own love of spirits is simply an unfortunate hereditary ancestral trait.

Comparisons are at the best odious; however, the most tender of us can always console himself by remembering that the comparison between man and animals and plants is only reasonable when we descend, as far as man is concerned, to the very lowest species of humanity, and even then he has to be compared with the highest type of the creatures below him. Therefore, indeed, what magnificent creatures we are—or, anyhow, might be!

I have seen dogs and, I think, other animals gazing abstractedly at and evidently following something. They were troubled, sometimes whining, or positively crouching in awe or dread. Such behavior in a dog during the course of a long life is not uncommon, and it would be ridiculous to declare all such dogs to be rabeitic. I believe other animals suffer from illusions. I know two men with whom I have spoken, and who are reasoning, rational beings, and otherwise very practical, who are able to make a chair waltz round the room or go up-stairs without in any way, directly or indirectly, having contact with it. Having started the chair on its career, it is kept going by mere suggestion. I ques-

tion and cross-question these gentlemen, and before witnesses, and they maintain their assertion stolidly; and I believe that they do see in their own mind the chairs doing all they say; but what this peculiar condition of mind implies I know not. To the majority of readers such tales appear mere vaporing. I can offer no explanation, except that these visions are not delusions, for the perpetrators are reasoning beings and sane; they are not illusions, for such gentlemen (and ladies, too, I believe, but I have not met them) believe that they are actually moving solid furniture merely by the force of their own suggestion. Such acts, so interpreted, appear to me to be only able to be likened to those of a deity—and a deity is beyond our comprehension. They are not due to animal magnetism. They are not dreams. The effect of suggestion by means of "hypnotism," with its startling results, has been witnessed by thousands, but any similar explanation breaks down here. If these things be true, then the connection between the animate and inanimate creation is complete. For obvious reasons, names can not be introduced into such a paper as this; but I believe that I could gain an introduction to one or both of these gentlemen for any person, sufficiently well known, and desirous of investigating such material.

The lower animals, then, in a degree, do almost all that we can do. Plants do many things that were once considered to be solely the doings of the animal creation. The ultimate structural elements of either will some day assist in the formation of mountains and seas. Therefore, indeed, we are all one—animal, plant, mountain, sea. The component elements and molecules of the animal and plant creation have simply become highly idealized and specialized. The marked difference between man and a mountain lies in the constant dissipation of energy by man and its passive retention by the mountain. The mountain is a mere reservoir of energy; man one of the compounds of elements used for the dissipation of energy.—*Gentleman's Magazine.*

THE difficulties that many have experienced in understanding the writings of the alchemists are accounted for by M. M. Pattison Muir by showing that the names they used and which have survived as the names of well-known substances were applied only to certain principles or properties that matter was supposed to possess. Thus the word sulphur represents the principle of changeability, and the word mercury the principles of malleability and luster which the metals exhibit. The alchemists used expressions of this kind partly to hide their secrets from the uninitiated, and partly to preserve themselves from the suspicion of dealing with the evil one, who was considered to be the possessor of the earth. The mystical language was derived, to a large extent, from theology. Possibly the alchemists attached some definite meanings to the fantastic terms they used, but the meanings are lost to us.

THE CHEMISTRY OF CLEANING.*

By Prof. VIVIAN LEWES.

AS a great city grows, and the agglomeration of struggling humanity increases, such questions as the disposal of sewage and other waste matter rise from comparative insignificance into problems of almost insurmountable difficulty; and while we are able to put the burden of cleansing our towns upon the urban authorities, the responsibility of keeping our homes and bodies in a condition of at least sanitary cleanliness devolves upon the individual, and a knowledge of the causes of dirt and the methods by which it can be removed can not be regarded as devoid of interest, or at any rate of utility.

Observation shows that in our town houses only a very short interval of time is needed to cause a considerable deposit of dust upon any horizontal surface, while vertical surfaces and draperies, especially if their surface be rough, also accumulate a perceptible quantity, although of a lighter and more finely divided kind. We also find that this dust is borne to its resting place by the air which penetrates from the outer atmosphere, and that its deposition is caused by the comparative condition of rest insured to it by the absence of wind or violent currents.

The presence of these air-borne particles of solid matter can be made visible in any town by allowing a beam of sunlight or a ray from an electric lantern to pass through the air of a darkened room. If the room be filled with air previously filtered by passing it through cotton wool, the beam of light is invisible until it strikes the opposite wall; but if the air be unfiltered, the path of the beam is mapped out by the suspended matter reflecting and dispersing portions of it, and so becoming visible to the eye as "the motes in the sunbeam." The heavier the nature of the particles the more quickly will they settle, with the result that the dust on horizontal surfaces, such as the tops of sideboard, piano, and mantel-board, may be expected to differ somewhat from the lighter form, which has continued to float until contact with vertical surfaces has brought it to rest.

These particles of dust are composed of matters of the most varied nature, and will be found, when collected, to consist partly of mineral and partly of organic substances.

The heavier portions of the dust are found to contain ground-up siliceous matter, pulverized by traffic in the road; small particles of salt carried inland by winds from the sea, together with sulphate of soda, with other impurities of a local character. If a

* Abridged from a lecture delivered at the London Institution.

sample of dust be collected and carefully ignited, the organic matter will be burned away and any ammonium salts volatilized, while the mineral portion will be unacted upon; and in this way it has been shown that more than one half of the suspended matters in the air are of organic origin, a large portion of this organic matter consisting of germs which are capable of setting up fermentation, disease, and decay.

It is only within the last few years that the importance of the work done by the solid particles of dust floating in the air has been recognized, and it is to Pasteur that we owe the knowledge that these germs set up the various processes of organic decay, by which the waste matter derived from vegetable sources is once again resolved into the water vapor and carbon dioxide used by Nature as the foundation of all organic creations. It is the almost imperceptible germs floating in the air which start this marvelous natural action—germs so minute that it requires the strongest microscope to detect them, yet so potent that the whole balance of life hangs on their existence. These facts show us that not only has dust a most marvelous history, but that in it Nature has disguised her most important factor for cleaning the face of the earth from waste matter of both mineral and vegetable origin.

The surface soil when mixed with water gives the mud which dirties our boots, and forms clots on the train of our skirts; but this, as well as the dust which has settled in our living rooms, and merely clings mechanically to the surfaces upon which it has deposited, may be removed by such simple physical means as the duster and brush. When dust has found its way into a fabric such as a carpet, it requires considerable force to again dislodge it, and this is applied by means of the broom; but in vigorous sweeping we find that the largest proportion of the dust is driven up into the air, only to resettle once again on other surfaces, so that although we can make the nuisance "move on," we do not in this way remove it, and experience has taught our servants that wet tea-leaves scattered on the carpet before sweeping lessen this evil. In some cases, instead of using this method, it has been argued that it must be the moisture which acts in preventing the raising of the dust, and the carpet has been sprinkled with water. This converts the dust into mud, which remains fixed in the fabric while the sweeping is going on, but as soon as the water has evaporated from it, again reasserts its right of rising as dust.

When, however, wet tea-leaves, damp sawdust, or even moistened sand is scattered over the surface to be swept, the dust when dislodged adheres to the moistened substance and is removed. In choosing moist bodies for this purpose, the only points to consider are that they must have no staining action on the carpet, must not be too wet, and must not be so finely grained as to

sink into the fabric, nor so clinging as to resist easy removal by the broom.

It is manifest, however, that the mechanically held dirt which we have been considering differs very considerably from the dirt on our skins, and on linen in contact with our bodies, which, although derived from the same sources as the dust on the furniture, resists any ordinary mechanical process for its removal, and rinsing dirty hands or linen in cold water has but little cleaning effect, while if the hands are afterward dried in the usual way a transfer of a portion of dirt to the towel takes place. If we carefully notice the portions of our skin and shirt which become most soiled, we at once observe that it is where the skin is exposed to air, while the linen, which is in contact with both air and skin, becomes dirty more quickly than when exposed to either alone.

The part played by the atmosphere is made clear by the facts which we have already been considering, but the action of the skin introduces a new and most important factor. For the healthy carrying on of the functions of life, nothing exceeds in importance the skin with which our body is covered. We may live for days without giving our stomach any work to do, the liver may cease action for several days before death ensues, but it is impossible to survive for the same length of time if the functions of the skin are entirely stopped. The skin not only plays an important part in throwing off and getting rid of waste matter from the system, but it is also credited with being an important auxiliary to our lungs; and experiments have clearly shown that if the skin of animals be coated in such a way as to completely stop its action, a very few hours will bring about death.

If we examine the structure of the skin, we find that it is built up of two distinct layers, an outer skin called the cuticle or epidermis, and an inner termed the cutis or dermis. A third layer intermediate between these two used to be looked upon as a third skin, but more recently has been recognized as being only a transition form of the outer skin. The cuticle or outer skin consists of several fine layers of scales which gradually assume a more rounded and granular form the deeper one gets into the cuticle. These rounded granules form the middle skin of the old observers, and as the outer portion of the cuticle roughens and scales off as scurf, these granules gradually flatten and form the new surface to the outer skin; and we differ therefore from other scaly reptiles by being continually in a condition of renewing our skin, while most reptiles and fish cast their scaly covering in one operation.

No nerves or blood-vessels find their way into this outer skin, as may be seen when it becomes detached from the inner skin in the formation of a blister, the outer portion of which is devoid of sensation. The lower or true skin varies in thickness, being

thicker in the palm of the hand and sole of the foot, where most resistance is needed. When we look at the skin of the hand, we notice delicate grooves in it, which, examined through a magnifying glass, are seen to be pierced with small orifices; and if the hand be warm, minute shining drops of perspiration will be seen issuing from them.

The glands for the secretion of the perspiration are set in the lower side of the inner skin and are in connection with the capillary network of blood-vessels which cover the surface of the body. The gland or duct which conducts the perspiration to the surface of the skin is about a quarter of an inch in length, and is straight in the true skin, but becomes spiral while traversing the outer skin. Over thirty-five hundred of these small ducts have been found to exist in a single square inch of the skin, and it has been computed that the aggregate length of the sudoriferous ducts in the body of an ordinary-sized man is about twenty-eight miles. These little glands and ducts perform the important function of throwing off the moisture produced during the combustion of waste tissue by the blood-borne oxygen of the body, and secrete about twenty-three ounces of perspiration in the twenty-four hours, which under ordinary conditions evaporates, without our noticing it, into the air, but under conditions of considerable exertion or unusual heat accumulates as beads of perspiration.

The throwing off of the perspiration and its evaporation on the skin is a beautiful natural contrivance for regulating the temperature of the body, as the conversion of the perspiration into vapor renders latent an enormous amount of heat, which, being principally derived from the body, keeps it in a comparative state of coolness even when subjected to high temperatures.

In the twenty-three ounces of liquid so secreted in the course of the twenty-four hours there will be found rather more than an ounce of solid matter, which is left when the liquid portion of the perspiration evaporates, and tends to clog the pores of the skin, and it is the removal of this by the morning tub and rough towel which is responsible for a considerable portion of the refreshing influence of the bath.

Besides these sudoriferous glands, however, there is a second set, called the sebaceous glands, the ducts of which are spiral, and open generally into little pits, out of which the fine hairs which stud the skin grow, and these glands secrete an oily or waxy substance, which nourishes the hair, and also keeps the outer skin smooth and pliant. This waxy substance is developed in largest quantity inside the ear, where it serves to protect the more delicate portions of that organ; and, next to the ear, these glands are found most abundantly on the face and other portions of the body which are exposed to external influences and friction.

It is the presence of this oily secretion which holds the dirt glued to the skin, and being also rubbed off on the inside of the wristbands and collars of our shirts, causes these portions of our linen to become the most soiled. We may look upon this form of dirt, therefore, as being glued on to the surface by oleaginous materials, which being insoluble in water resist any mere rinsing; and the most important function of our cleansing materials is to provide a solvent which shall be able to loosen the oil, and so allow of the removal of dirt from the skin. The skin, however, is not the only source of oily matter, and in all fibers of animal origin more or less fat is to be found, which, although not in sufficient quantity to play any very important part in the fixation of dirt, still adds its iota to the general result.

We notice, moreover, that the air of a big town has a far greater dirtying effect than country air, this being partly due to the fact that the number of solid particles per cubic foot of atmosphere are greatly increased, but chiefly because country air does not contain certain products of incomplete combustion, which are to be found in all large towns. In London we annually consume some six million tons of bituminous coals, and if we examine the smoke which escapes up our chimney during the imperfect combustion which the coals undergo in our fire grates, we find that not only will that smoke contain small particles of unconsumed carbon in the form of blacks or soot, but also a considerable quantity of the vapor of condensible hydrocarbon oils, which, depositing on the surface of the solid particles of floating dirt, gives them an enhanced power of clinging to any surface with which they come in contact.

Hydrocarbon oils of this character are not as a rule affected by the solvents which we utilize for loosening the dirt which is held to our skin by animal grease; but there is no doubt that the dirtying influence of town air is greatly increased by their presence.

If we take any grease of vegetable or animal origin, we find that it can be dissolved in liquids containing free alkalies, this term being applied to the compounds formed by water with the soluble metallic oxides, which, when dissolved in water, give solutions having a soaplike taste, affecting the color of vegetable extracts, such as that obtained by the red cabbage, and possessing the power of neutralizing the acidulous properties of the compounds we call acids.

If we take two metals discovered by Sir Humphry Davy in 1807—potassium and sodium—and expose them to dry, pure air, they rapidly become converted into a white powder by absorbing oxygen from the atmosphere, and form compounds which we term respectively oxide of sodium and oxide of potassium. These

oxides, when dissolved in water, enter into combination with a portion of it, producing sodic hydrate and potassic hydrate, two substances which have pre-eminently the properties which we term alkaline, and which exert a strong solvent action upon all forms of animal and vegetable grease. These solutions exercise a wonderful power of cleansing upon the grease-bound particles of dirt which veil our skin, but so strong is their solvent power upon animal membrane, that not only do they dissolve fatty matter, but also the cuticle itself, so that they are manifestly unfitted for removing dirt from a tender skin, and we are forced to look further afield for a grease solvent.

If instead of dissolving our sodic and potassic oxide in water we had left them exposed to ordinary air, we should have found that they gradually attracted from the atmosphere a gas called carbon dioxide, which exists in all air to the extent of four parts in ten thousand, and that by combining with this gas they became converted into sodic and potassic carbonates, bodies which we call salts, and which, although not so violent in their action upon the skin, will retain to a certain extent their solvent action on fatty matters.

The carbonates of sodium and potassium are found in the ashes of many vegetable and animal substances, and in the earliest records which have been discovered we find mention of the cleansing power of wood ashes, the ashes of certain marine plants, seaweed, and "natron," which is an alkaline efflorescence from some kinds of soil; nor has the use of ashes for this purpose entirely died out at the present time.

As early as A. D. 69, however, we find that the elder Pliny mentions another form of cleansing material made from tallow and ashes, the components most recommended being goat's suet and the ash of beechwood; while the ruins of Pompeii were found to contain a fairly perfect soap factory.

Although soap and Christianity date from the same period, it was only at the commencement of this century that the classical researches of Chevreul on the constitution of fats gave the key to the reactions taking place during its formation, while even at the present time we probably only know a true explanation of part of the actions which lead to its cleansing effect upon the skin.

If we take sulphuric acid diluted with water, we find that it has certain well-marked characteristics which leave no room for doubting its acidulous nature; and if we pour a few drops of it into the violet-colored solution obtained by boiling sliced red cabbage in water, the violet solution at once becomes bright red. On repeating this experiment with the violet cabbage solution and a few drops of sodic hydrate solution, we obtain a vivid green

color; and now on mixing the solution rendered red by the acid, and the second one turned green by the alkaline base, we once more obtain the original violet color, and on examining the solution can find no trace of either acid or alkali, but can distinguish the presence of a compound called sodic sulphate, which can be obtained in the crystalline form by concentrating the solution, and such a compound formed by the union of an acid and a base we are in the habit of calling a salt. During the combination of the sulphuric acid and sodic hydrate to form sodic sulphate, we also had water being formed, which, like the neutral salt, had no action upon our colored solution. If we had carefully weighed our sulphuric acid and the sodic hydrate, we should have found that it is only in certain definite proportions that they unite to give a solution without effect on the vegetable coloring matter.

One of Chevreul's greatest discoveries was that in tallow—the fat of oxen or sheep—you had a salt of organic origin, from which, by decomposing the tallow with heated steam, you could obtain the sweet viscous liquid "glycerin," which played the part of base in the compound, and two acidulous compounds—one a lustrous white wax, called stearic acid, and the other an oil called oleic acid.

Now a salt can have its base replaced by another base. If I take two solutions, the one containing sulphate of copper and the other chloride of iron, and add to each sodic hydrate, decomposition takes place in each case, sodic sulphate is left in solution, and the hydrates of copper and iron being insoluble in water, separate out as precipitates. In the same way, if we add sodic hydrate to tallow, glycerin separates out, and two salts—sodic oleate and sodic stearate—are formed, a process which we call saponification, as the two sodium salts are "soaps."

It is not necessary to use tallow; any vegetable or animal fat or oil will give reactions of a similar character, and it may be broadly stated that soap is formed by the action of sodic or potassic hydrate upon fats or oils which contain fatty acids.

It is only potassic and sodic hydrates which can be used for ordinary soap-making, as the soaps formed by the combination of other metallic hydrates with the fatty acids are insoluble in water, and therefore useless for detergent purposes. The soap formed by using sodic hydrate has the property of setting hard, and all the ordinary forms of washing-soap contain sodium as the base. The potash soaps are far softer, and do not set; the soft soap used for scrubbing and cleansing in many manufacturing processes, and also a few toilet creams and shaving pastes, being of this character.

It would occupy far too much time, and would, moreover, be outside the scope of this lecture, to go into the details of the

manufacturing methods by which soap is made on the large scale, and if I give a rough idea of the general processes employed it will be sufficient for the purpose.

Carbonate of soda is first converted into hydrate by dissolving it in water and then boiling with quicklime. Quicklime consists of calcic oxide, and this, when put into the vat containing the sodic carbonate in solution, combines with water, forming calcic hydrate, which then reacts with the sodic carbonate, forming calcic carbonate or chalk, which being insoluble sinks as a mud to the bottom of the vessel, while sodic hydrate remains in solution.

The solution of sodic hydrate, called caustic lye, is made in different strengths, and tallow is first boiled with a weak lye, and as the conversion into soap proceeds, so stronger lyes are used until the whole of the fatty matter has been saponified. If a strong lye had been used at first, the soap as it formed being insoluble in strong alkalies would have coated the surface of the fat and prevented its complete conversion.

If at the end of the saponification process the alkaline solution is sufficiently strong, the soap will, on standing, separate as a fluid layer on the surface of the spent lye, which contains the glycerin set free during the saponification; but in any case separation can be rapidly brought about by adding salt to the liquid, when the soap, being insoluble in salt water or brine, separates out and is removed and placed in molds to harden. The block of soap so cast is then cut first into slabs and then again into bars. A soap made in this way with tallow or lard as the fatty matter would be "white curd," while if yellow bar is required, rosin is added to the mixture of lye and soap after most of the fat has saponified.

When rosin is boiled with alkaline solutions, a compound is formed by the direct union of the resinous acids with the alkali, which strongly resembles ordinary soap, so that the yellow soap is really a mixture of fatty and rosin soap, and when the ingredients are of great purity the product goes by the name of "primrose" soap. Bar soaps so made on a large scale are, as a rule, the stock from which the various forms of toilet soap are made by processes intended to render them more attractive for personal use, but generally the consumer gets far better value for his money, and far less injury to his skin, by using a good "white curd" or "primrose" soap than by employing a high-priced toilet soap, while cheap toilet soaps, especially cheap transparent soaps, should be studiously avoided.

The demand made by consumers for cheap soaps, which in many cases are sold retail at prices considerably below the wholesale market price for a true soap, has given rise to the introduction of highly watered soaps, caused to set hard by the addition during manufacture of sodic sulphate, which enables the manu-

facturer to make a so-called soap often containing less than twenty per cent of true soap.

Having got our soap, the next point is to try and gain an idea of the way in which it acts as a detergent. Supposing we are fortunate enough to have a sample of pure neutral soap, we find that, on dissolving some of it in water, it undergoes a partial decomposition into alkali and fatty acid, this action being called the hydrolysis of soap. The small quantity of alkali so set free attacks the fatty matter which glues the dirt to the skin, and by dissolving it loosens and enables the water to wash off the particles of dirt. If this were the only action, however, soap would have no advantage over soda, a solution of which would equally well perform this part of the operation. As the soap decomposes and the alkali removes the grease and dirt, the fatty acid liberated simultaneously from the soap comes in contact with the newly cleansed skin, and not only softens and smooths it, but also neutralizes any trace of free alkali, and so prevents irritation and reddening of the cuticle.

These are probably the main actions by which soap cleanses, but other causes also play a subsidiary part. We know that a solution of soap causes a lather when agitated, this being due to the cohesive power given to the particles of which the liquid is built up by the presence of the soap a phenomenon which also enables us to blow bubbles with the soap solution on account of the strength of the fine film of liquid—a property which is not found in water alone.

The power of cohesion which the soap solution possesses is in all probability an important factor in removing the particles of dirt from the skin at the moment that they are loosened by the action of the alkali. Prof. W. Stanley Jevons suggested yet a fourth way in which the soap solution might act: when finely divided clay is suspended in water, the microscope reveals the fact that the minute particles are in rapid movement, and hence settle but slowly in the liquid. This movement he christened pedetic action, and he observed that the addition of soap or silicate of soda—often used in soap—to the liquid enormously increased this agitation of the particles, which would tend to aid the breaking away of the dirt particles the moment they were set free.

Many soaps, even among the varieties intended for the toilet, contain a considerable excess of free alkali, which, being greater than the liberated fatty acids can neutralize, causes most painful irritation of the skin, as is testified by the smarting which annoys the chin after the use of certain shaving soaps; and every lady knows that an alkaline soap, when used for washing the hair, renders it harsh and brittle, and destroys the gloss; but a

rapid rinse with water containing a few drops of vinegar will neutralize the free alkali and prevent much of the mischief.

We have now dealt with our grease solvents and dirt looseners, but without the aid of water they would be useless; and experience teaches us that the source of the water used for cleansing has a great deal to do with its efficiency.

As the newborn raindrops fall from the breaking clouds, they are practically pure water, containing at most traces of gaseous impurities which the mist has dissolved from the upper strata of air while journeying in the form of cloud, and where the rain is collected in the open country, it gives us the purest form of natural water healthful to drink, because it is highly aërated, and free from all impurity, organic and inorganic, and delightful to wash in because of its softness and the ease with which the soap gives a lather.

In towns, however, a very different state of things exists, as the rain in falling washes the air from a large proportion of the suspended organic matters inseparable from a crowded city, and also from the unburned particles of carbon, which incomplete combustion allows to escape from our chimneys; and charged with these, it still collects more dirt of various kinds from the roofs of our houses, and finally finds its way into our water-butts as the semiputrid sludge which often causes the true-bred cockney to wonder "if this so-called purest form of natural water is so foul, what on earth must the other forms of water be like?" If in the country the rain water is collected and stored in suitable reservoirs, then we have the most perfect water that can be obtained for washing and cleansing purposes.

In the passage of the rain through the air small quantities of carbon dioxide or carbonic-acid gas are dissolved from the atmosphere, while in slowly percolating through the surface soil on which it has fallen the water is brought in contact in the pores of the soil with far larger volumes of this gas, which is being continually generated there by the decomposing vegetation and other organic matter in a state of decay. Under these circumstances the water becomes highly charged with the gas, and sinks on through the ground until it comes in contact with some impermeable strata through which it can not penetrate, and here it collects until a sufficient head of water has been formed for it to force its way along the strata to the surface of the earth, where it now appears as a spring, and during this passage through the earth it has dissolved everything that will yield to its own solvent action or to the activity of the carbon dioxide, which dissolved in water forms the weak carbonic acid, a compound which will dissolve many substances insoluble in the water itself, such as calcic carbonate, occurring in the soil as marble, limestone, or chalk,

and also the carbonates of iron and magnesium. If we examine a spring water, we shall find that its dissolved impurities can be divided into two classes: for instance, taking the Kent water supplied at Greenwich, and obtained from deep wells in the chalk, we find its saline constituents in grains per gallon are:

Calcic carbonate	16·30
Calcic sulphate	5·37
Magnesic sulphate	0·93
Magnesic nitrate	1·20
Sodic chloride	2·64
Sodic nitrate	1·21
Silica, alumina, etc.	0·97

And of these the calcic sulphate, magnesium, and sodium salts are dissolved by the solvent action of the water in the same way that sugar would be, while the chief impurity, calcic carbonate, is scarcely at all soluble in the water itself, 16,000 parts of pure water only dissolving one part of the carbonate, but is readily soluble in the carbonic acid, in the water which converts it into soluble calcic bicarbonate.

In the household, waters are roughly classified as hard or soft waters, and the property of hardness manifests itself, as a rule, to the householder by its action upon soap, and also by the amount of "fur" which it causes in the kettle, these actions being due to calcic bicarbonate, calcic sulphate, and the magnesium salts present in it, all of which act upon soap and cause it to curd instead of forming a lather by converting the soluble sodic oleate and stearate into insoluble lime salts, while the bicarbonate by decomposing and depositing "chalk" causes the fur.

A more careful examination, however, reveals the fact that this property of hardness owes its origin to two different causes; for if we boil water until all the bicarbonate is broken up and the calcic carbonate deposited, the clear water left behind it is yet hard, though to a far less extent, and will still decompose a certain proportion of soap. The hardness which can be got rid of by boiling is due to bicarbonate of lime, and sometimes also bicarbonate of magnesia, and is called "temporary hardness," while the hardness left after boiling the water is due to calcic sulphate and the soluble magnesium sulphate, chloride and nitrate, and is called "permanent hardness."

The relative hardness of waters is estimated by the amount of soap they will destroy—i. e., convert from the form of soluble sodic oleate and stearate into the condition of insoluble oleates and stearates of lime; and one grain of calcic carbonate, or its equivalent in sulphate or salts of magnesia, dissolved in a gallon of water, is said to equal 1° of hardness.

PHILIBERT COMMERSON, "THE KING'S NATURALIST."

ONE of the most successful exploring and scientific expeditions of the eighteenth century was that of Louis Antoine de Bougainville, which, starting from one of the ports of France in the last days of 1766, passed through the strait of Magellan and entered the south seas, still for the most part unexplored; sailed through the Paumotu Archipelago, discovering several islands then yet unknown; visited Tahiti; touched the New Hebrides, passed the eastern coast of Australia, the Louisiade Islands, and the Solomon Islands; stopped at New Ireland to repair the ships; passed the northern shore of New Guinea; visited Booro, in the Moluccas; and returning, reached St. Malo in March, 1769. Not the least among the scientific gains of the expedition were those in botany, and these accrued wholly through the fidelity to science and diligent industry of Philibert Commerson, than whom, says the Edinburgh Review, "no explorer of the globe ever conveyed to Europe so large a number of valuable plants, previously unknown."

Commerson was recognized in Europe, though personally but little known, as one of the first botanists of the age. He was the correspondent of Linnæus, the friend of Haller, and the colleague of the two Jussieus. He was the grandson of a retired nobleman of the days of Louis XIV, who had dropped the *de* distinctive of his rank, and the second son of Georges-Marie Commerson and Jeanne-Marie Mazuyer, and was born at Châtillon-les-Dombes, in Burgundy, November 18, 1727. He studied while a child under a Gray Friar at Bourg-en-Brosse, who became interested in him, and, taking him on his daily walks, inculcated in him the first principles of botany and a love of plants and of natural history. The district abounded in fish ponds, and wandering among them he gained a familiarity with fresh-water fish to which may be attributed his subsequent skill as an ichthyologist; and "his facility in manipulating, preserving, and drying certain fit specimens of the smaller fry, like plants, between sheets of coarse paper, first practiced by him for scientific purposes," was evidently acquired by him during this period. After two years at Bourg, he was sent to the Benedictine College near Mâcon, about 1742, to study for the law; but the scientific books of the abbey library had more attractions for him than the law books, and he was fonder of outdoor life than of studying his dry text-books. His father, willing that he should follow in the direction of his tastes, sent him to the University of Montpellier to read for the medical degree in 1747. He had already begun the preparation of a herbarium, and spared no efforts to make it the most complete in existence.

He spent four years at Montpellier after taking his degree, and in botanizing in the Cevennes, the Pyrenees, and Provence, and on the littoral of the Mediterranean. He soon became known throughout Europe as a naturalist of exceptional talent and experience. He was introduced to Linnæus and was commissioned by him to describe the fishes of the Mediterranean for the museum of Queen Louisa Ulrica at Dronningholm, near Stockholm. He prepared a list of all the botanists who had suffered in the pursuit of their calling, entitled the *Martyrologie de la Botanique*, in which he came near having his own name recorded even thus early, having been poisoned by the saliva of his own dog gone mad, and he wrote to one of his friends that he expected some day to figure upon the roll. This work seems never to have been published, and it is not known where the manuscript is. Coming to Dijon in his travels, M. de Beost, an officer of the states of Burgundy, gave him the privileges of his fine garden, glass houses, and library. Having explored Savoy, he visited the mountains of Switzerland, and, calling upon Voltaire at Geneva, received from him the offer of a secretaryship, which he declined. Then he settled down for a time at Châtillon, his native home, where he put himself in communication with correspondents who furnished him seeds and plants. He studied and explored and experimented with a reckless devotion which called forth from Lalande another prediction that his zeal would some day kill him. His overwork resulted in fever, in the convalescence from which he made the acquaintance of the young woman—"a sensitive plant," he called her—who became his wife: a daughter of M. Jean Beau, who died after two years of happy married life, leaving a son who survived him many years. To the memory of his wife, making a fanciful translation of her maiden name, Beau, he dedicated the genus *Pulcheria*—a plant not distinctly identified, but which was described as bearing a fruit that inclosed two kernels united in the shape of two hearts.

He removed to Paris in 1764, where, introduced by Lalande and Bernard de Jussieu, he was readily welcomed into the inner circle of learned society and gained the position and recognition he merited. In October, 1766, Commerson was appointed by the French Minister of the Marine, on the recommendation of Poissonier and the Abbé Lachapelle, of the Academy of Sciences, "botanist and naturalist of the king" to Bougainville's expedition of circumnavigation, then in course of organization at Nantes and Rochefort. The title given him was very grateful to him on account of the privileges it brought; that of botanist to the king had been conferred on only two or three men of science, and always led to a pension, while that of naturalist was a distinction which no one before him had obtained. He was first

directed to draw up a report regarding the class of observations on natural history which he proposed should be carried out during the expedition. It suggested observations in three kingdoms of Nature, animal, vegetable, and mineral, to which was added a fourth class of physical and meteorological observations. "The class of quadrupeds," he said, "being subordinate to man, that being should always first attract the attention of the traveler naturalist. . . . The first shade after man is that of the anthropomorphic animals or apes with a human figure, of which it would be desirable to know all the series, because they establish an insensible passage from man to the quadrupeds."

Before leaving Paris for his voyage, Commerson made his will, in which he provided for the endowment as a *Prix de Vertu* of a medal of two hundred livres, bearing on its obverse face an inscription signifying that it was a reward for the practice of virtue, and on the reverse one signifying that the unworthy "P. C." had dedicated it. It was very like the Montyon prizes, afterward established and carried into effect. Having set out from Rochefort, after considerable delay, the expedition reached the mouth of the Rio de la Plata in May, 1767, and remained for some time at Montevideo to repair damages suffered from a storm. Here Commerson was astonished at the superfluity of horses and cattle, and wrote to his brother-in-law, further: "I have not failed to reap a fruitful harvest of plants, birds, and fishes, and I am anxious that nothing should escape me; but what can I do? I am neither an Argus nor a Briareus; a single day's hunting, fishing, or even a walk places me in the embarrassment of Midas, under whose hands everything became golden. Ofttimes I do not know when or how to begin, and I have scarcely time to eat or drink, so that my excellent friend, our good captain, is obliged to forbid my lamp being kept alight after midnight, because he has foreseen that I should deprive myself of sleep all night to gain sufficient time to examine all which is before me. The keen admiration which seizes me in viewing so many varieties, most of them new and unknown to science, has forced me to become a draughtsman."

From Montevideo the vessel, L'Étoile, proceeded to Rio Janeiro. In one of his excursions Commerson noticed some trees having a rosy mauve or magenta tint, which further examination showed him was given them by their brilliantly colored bracts. They were trees of a new genus, which he named Bougainvillea, after his commander. The genus has become familiar in conservatories. Returning to the Rio de la Plata, Commerson declined an invitation from the viceroy, Don Francisco Bucarelli, to go with him across the Andes to Chili and Peru. Proceeding onward again in November and December, 1767, the expedition sailed into

the strait of Magellan. Thence they they went northwesterly into the Pacific Ocean; passed the Paumotu, or Low Archipelago; and visited Tahiti, of which Commerson has left a famous description in a letter to Lalande; continued to sail westwardly; sighted Samoa; were perplexed by the Great Barrier Reef, and had to make a back track along the Louisiade Archipelago to the Solomon Islands; between New Britain and New Ireland; along the northern shores of Papua; thence to Batavia; and finally, to Port Louis. Here M. Poivre, intendant of the colony, had orders from the authorities at home to retain Commerson for service under his direction; while Véron, the astronomer, was directed to proceed to India, to observe the forthcoming transit of Venus. Commerson was the first European to ascend the native volcano of Bourbon and to make a complete collection of mineralogical specimens from its hardly accessible craters. His account of a pygmy tribe inhabiting the mountain regions of Madagascar, after having been long contradicted, has recently been confirmed by the Rev. E. O. MacMahon, of the Society for the Propagation of the Gospel.

Commerson's career now soon came to an end. Among the results of political changes in the colony and in France were the withdrawal of ministerial patronage from him, the stoppage of his salary as naturalist to the king, and his dismissal. His health had already given way in consequence of the exposures to which he had subjected himself, and he was suffering from dysentery and rheumatism. He gave himself up to the study of the flora of Mauritius, writing to his friend Lemeunier: "My plants, my dear plants, have consoled me for all. I have found the nepenthe, the sweet assuagement of cares." He sought rest in another part of the island, but died, March 14, 1773, at the house of M. Bézac, a planter, near Flacq.

Commerson left his collections of plants, fishes, minerals, and manuscripts, thirty-two cases in all, to the Royal Museum of Natural History in Paris. They included, with two hundred folio volumes of herbaria, five thousand plants, of which three thousand species and one hundred and sixty genera were new to science.

In a collection made by Captain W. G. Thorold in Thibet of plants growing at elevations between 15,000 and 19,000 feet, fifty-seven, or one half, were found between 17,000 and 18,000 feet, five between 18,000 and 19,000, and one, *Saussurea tridactyla*, at 19,000 feet. A large majority of the plants hardly lift themselves above the surface, the characteristic type being a rosette of small leaves closely appressed to the ground with a central sessile inflorescence. Judging from the fact that many of the species are found in the most widely separated parts of the country, there must be very few local species; and the circumstances indicate that the distribution marks the remains of a once probably much richer flora.

SKETCH OF SEARS COOK WALKER.

A FEW years before the middle of the present century the condition of science in America was far from inspiring. Although this country had long since ceased to be a dependency of Great Britain politically, it still seemed unable to rise out of such a position intellectually. In science and letters English authority was paramount. To the generality of American scholars a grudging mention in an English publication outweighed domestic honors of a much higher grade. Scientific treatises emanating from Great Britain were accepted as gospel, while the science of the rest of Europe was known only through British translations. There were a few men of science who were independent in the midst of dependency. The above description shows the general character of a period happily long since brought to an end, and among those most active in bringing about its end was the subject of the present article.

SEARS COOK WALKER was born March 28, 1805, in Wilmington, a small town of Massachusetts, about sixteen miles northwest of Boston, where four generations of his ancestors had lived and died. His father's mother was descended in a direct line from the celebrated Elder Brewster, who came over in the Mayflower. Sears was a delicate child and so precocious intellectually that he early became the wonder of the village. His father had died when he was a mere infant, so that his whole care and training devolved upon his mother. She fortunately realized the importance of providing for his physical welfare and checking his too great fondness for books. It was a constant struggle with the boy's natural inclinations to do this, but the effort was successful. He joined heartily in many of the sports of his companions, and gradually gained a good measure of health and strength.

Young Walker took the studies preparatory for college at the academies of Andover, Tyngsborough, and Billerica; then went to Harvard, where he was graduated in the class of 1825. Immediately after his graduation he took up teaching as an occupation and followed it for ten years—the first two years in the vicinity of Boston and the rest of the time in Philadelphia. From 1836 to 1845 he was actuary of the Pennsylvania Company for the Insurance of Lives and Granting Annuities. His life in Philadelphia was a period of prosperity and comfort; he, moreover, early took on a corpulent habit of body, so that whatever influence his circumstances exerted was adverse to any strenuous intellectual exertions, and to the obtaining of adequate physical exercise. Yet his mind was one that could not be idle. "While engaged with his school," says Benjamin A. Gould, in his memorial ad-

dress,* "he studied medicine, and went through the whole course requisite for the attainment of a degree. He devoted his leisure for a period to the study of natural history, and was no mean proficient in geology and mineralogy, as well as in physics and chemistry. He was an active member of the Pennsylvania Geological Society, of the Committee of the Franklin Institute on Science and Art, and one of the most useful members of the American Philosophical Society. By frequent articles upon scientific topics in the various prints, by elaborate reports upon various subjects to the Franklin Institute, and by monthly announcements in its Journal of occultations and other celestial phenomena, he kept awake the interest and sympathy of the community for studies of this character. Among other labors, he prepared, in 1834, an ingenious set of parallactic tables, by which the time required for computing the phases of an occultation was reduced to less than half an hour. These were calculated for the latitude of Philadelphia, and it was his intention to publish them in a more general form adapted to different latitudes. But, as this would have been a work requiring considerable time, he subsequently abandoned the project, believing that he could employ his leisure hours more usefully. He continued the computation of the occultations without interruption for six years, and then induced our well-known colleague, Mr. Downes, to undertake the continuance of the work. It has been prosecuted to the present time, with what success we all know, and has of late years been published by the Smithsonian Institution and the Astronomical Ephemeris. Astronomy and geography in America are much indebted to Mr. Walker for these labors, since many already in possession of the necessary means were stimulated by the periodical announcements, and by his personal exertions in still other ways, direct and indirect, to observe these phenomena. An extensive series of such observations was collected by Mr. Walker and published in the Proceedings of the American Philosophical Society."

During most of Walker's residence in Philadelphia he must be regarded as an amateur rather than a scientist. For many years his interest in Nature was spread over several fields, but gradually it concentrated upon astronomy. He had procured an astronomical clock, a twenty-inch transit instrument, and a small Dollond telescope, and from about the time when he gave up his school to become actuary of the insurance company all his leisure was devoted to astronomical observation and study. "In 1837,"

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* An Address in Commemoration of Sears Cook Walker, delivered before the American Association for the Advancement of Science, at its meeting in Washington, April 29, 1854. From this address many facts concerning Walker's life and work in addition to the above quotation have been drawn.

Dr. Gould's account continues, "he was invited to propose a plan for an observatory in connection with the Philadelphia High School, an invitation which he accepted with eagerness. In accordance with his suggestion, the committee in charge of the school imported from Munich the excellent Fraunhofer equatorial and Ertel meridian circle which, in his hands and those of his accomplished brother, the present director of the observatory, have done so much for astronomy in America—not merely by the number of observations made with them, but also by the incentive which they afforded to the lovers of astronomy in other parts of the country. It is unquestionable that in several instances they induced successful efforts for the procurement of similar and even superior apparatus elsewhere." The results of Walker's researches appeared from time to time in the publications of the American Philosophical Society and various journals. It was in 1841 that he may be said to have "earned his spurs" by a paper on the periodical meteors of August and November, which for many years remained the most important memoir on the subject that had appeared. From that time on he is to be ranked among scientific investigators.

In 1845 Mr. Walker's affairs underwent a revolution. Certain commercial operations turned out disastrously and entirely bereft him of means. The sense of defeat, the loss of luxuries at a time of life when habits have become fixed, together with anxiety for the future, made the blow a hard one. But it revealed to him, and to the world, the extent of his own scientific ability, and opened the way to higher intellectual gratifications, which he quickly learned to appreciate. The Secretary of the Navy offered him a position in the observatory at Washington which he at once accepted. Here, for the first time, the facilities which his special gifts required were at his disposal, and he immediately proceeded to make good use of them. After a short time he gave up his position at the observatory to accept the direction of the longitude department of the Coast Survey—an office which he ably filled until his last illness.

Early in 1847, while engaged in researches upon the then newly discovered planet Neptune, he became convinced that a star observed by Lalande in May, 1795, must have been this planet. With the telescope of the Naval Observatory Prof. Hubbard confirmed this conjecture, and astronomers were thus furnished with an observation of Neptune made fifty-two years before, which afforded means for a most accurate determination of the planet's orbit. The American was none too soon to secure priority, for, quite independently, the same important fact was laboriously hunted down in Europe by Petersen only a few weeks later. Walker now attacked the problem of Neptune's orbit; Benjamin

Peirce was at the same time calculating the planet's perturbations. The approximate results of each furthered the computations of the other, so that within eighteen months from the discovery of the planet these two Americans had attained a remarkably accurate statement of its theory.

In conjunction with Prof. A. D. Bache, Superintendent of the Coast Survey, Walker developed the method of determining differences of longitude by telegraph. What was the separate share of each of these two men in this work will probably never be known, for each ascribed the chief merit to the other. One feature introduced by Walker was the application of the method of coincidence of beats to the comparison of timekeepers—one indicating mean, the other sidereal time—at the two ends of a telegraphic line. These beats were signalized from one station to the other by taps of an observer upon the telegraph key. Such signals are, of course, subject to the errors that always attend the action of human nerves and muscles, so the next problem was to make the clock give its own signals. Two methods had been proposed, but there were fears—groundless they have since been proved—that either of these would injuriously affect the running of the clock. Mr. Walker sought diligently for some apparatus that would not arouse any such fears. He propounded the problem to several astronomers, and two or three contrivances were devised for the purpose.

This mode of observation and the apparatus invented to meet its requirements proved valuable not alone for determinations of longitude, but also for all other astronomical observations requiring minute precision in the determination of time. The mental effort required of the observer being reduced to a minimum, many more transits could be observed at a single meridian passage. Walker immediately modified the transit instrument to suit the new requirements, and, instead of five, seven, or at most nine threads, he provided it with several tallies of five threads each. There remained but one requisite to complete the American method of observation. This was some mechanical contrivance for securing a uniform rotary motion of the record sheet. It had not been attained when Walker died, although some progress toward the solution of the problem had been made.

It is proper for the biographer to point out the share which Walker personally had in this series of inventions, although he was far from making any such claims for himself. With a fine comradeship he was jealous only for the credit of the organization of which he was a member—the United States Coast Survey. Speaking to the American Association for the Advancement of Science, Walker said: "With the single exception of the experiment between Baltimore and Washington, in 1844, I know of

no telegraphic operation for longitude, and of no step in the improvement or perfectionment of the art, in Europe or America, which has not been the work of the officers proper of the Coast Survey, or of commissioned officers and civilians acting temporarily as assistants. . . . I will not here allude to the respective claims of Americans for priority or superior excellence of inventions and suggestions, believing that it will be becoming for all of us to look to the great work that has been accomplished by our united efforts, rather than to the single share of each."

The transmission of observations by telegraph between Cambridge, New York, Philadelphia, and Washington furnished Walker an opportunity for another important discovery. He found that an appreciable time was required for the passage of these signals, and that this time was less than one tenth of that required for the passage of light over an equal distance in space. This result was so greatly at variance with the ideas of electricity current at the time that it was not accepted in America until the celebrated velocity experiments between St. Louis and Washington put it beyond question, and even after that some European physicists still refused to be convinced. While the matter was in dispute Walker was generous with aid and encouragement to those who sought to test his discovery, whether their results seemed likely to conflict with or to confirm his own.

The English Nautical Almanac for 1856 (issued in 1853) contained a profound discussion, by the astronomer Adams, of the amount of the lunar parallax. In this paper Adams showed that the tables of Burckhardt, which had been the standard ones, contained errors sometimes amounting to 6″, and pointed out the effect that such errors must have upon determinations of longitude from occultations. In the greater part of this discovery Walker had anticipated the renowned Adams by more than four years. In April, 1848, he had presented to his chief in the Coast Survey a report on longitudes in the course of which he pointed out the chief errors of Burckhardt's tables, giving four out of the five principal terms with remarkable precision.

Mr. Walker's intellectual labor was intense and unremitting; it was scarcely interrupted even in summer, when he was accustomed to betake himself to Cambridge, to escape the heat of Washington. During one of these summer sojourns, in August, 1851, he suffered a slight attack of paralysis, which for a few days deprived him of the use of one hand. This warning and the entreaties of his friends were not enough to induce him to relax his exertions. In the following autumn he took charge of the expedition for determining telegraphically the differences of longitude between Halifax, Bangor, and Cambridge. Immediately after his return to Washington, at about the end of December, symptoms

of mental alienation appeared, and he was taken to the hospital at Mount Hope, near Baltimore. Thence he was removed in the following April to Trenton, N. J., where under the skillful care of Dr. Buttolph, the superintendent of the institution, his disordered brain gradually regained its normal tone. Visits of friends, correspondence on the subjects of his researches, and finally his books and papers were allowed him. While still at Trenton he computed the ephemeris of Neptune for the American Astronomical Ephemeris of 1855. In the fall of 1852 Mr. Walker left the asylum apparently cured, although much debilitated by his illness, and went to Cincinnati for a visit to his brother, Hon. Timothy Walker, intending to remain until the following spring. He took in hand certain labors for the Coast Survey and prepared to resume in full his former sphere of activity. He had fixed a time for returning to Washington and re-engaged his apartments in the city, but he was not destined to make the journey. An attack of fever was followed by other maladies, and Walker soon found himself engaged in a second severe struggle with disease. In this condition Hamlet's problem—"To be, or not to be"—forced itself upon his thought with all its puzzling considerations. The sound mind in a sound body can give but one reply to this problem, but coming as it did to Walker at a moment when Reason was not firm in her seat, it elicited the opposite response, and on January 30, 1853, he launched himself into the mysterious after-life. His remains were placed in Spring Grove Cemetery, near Cincinnati.

The character of Sears Walker was marked by a childlike simplicity which many persons could hardly realize was not assumed to cover shrewd designs. He was impulsive, but his impulses were always noble and generous. Highly magnanimous, he was always prompt to acknowledge an error, and to overlook not only mistakes but even lapses from honor and justice in others. Intellectually he had the ability of genius. He was unadapted and disinclined for participation in the world's affairs, and could not refrain sufficiently for his physical welfare from intellectual labor.

Although his fame was won in the abstruse field of mathematics, his linguistic attainments were of a high order. In college he was as conspicuous for his classical as for his mathematical ability. During his years of teaching his knowledge of the languages was in daily use, and throughout life the literatures of Greece, of Rome, and of Italy were a source of enjoyment to him. His powerfully retentive memory was stored with long passages from the poets of the past, Tasso being his especial favorite.

EDITOR'S TABLE.

BACK TO DOGMA!

THE Marquis of Salisbury did not adopt the above words as the motto of his recent presidential address to the British Association, but he might have done so, for they fairly sum up the drift and spirit of that able but decidedly reactionary performance, the full text of which will be found in our present number. His lordship, it will be seen, thought it well to remind his hearers of "the condition in which we stand toward three or four of the most important physical questions which it has been the effort of the last century to solve," or, as he also described them, "stupendous problems of natural study which still defy our investigation." It is well to have our attention drawn as often as may be necessary to unsettled problems, provided it be done for the purpose of facilitating and encouraging further effort toward their solution. Whether that was the object which his lordship had in view, or at heart, is rendered a little doubtful by the tenor and particularly by the conclusion of his discourse. He showed that chemical science has not yet succeeded in explaining the nature and origin of the so-called elementary bodies, of which not less than sixty-five are recognized. He next observed how completely we had also failed to obtain any knowledge of the ether beyond the necessary assumption that it is an undulating medium. Turning to biology, he dwelt upon the fact that, although chemists have succeeded in manufacturing certain substances which had previously only been produced in living bodies, no living organism had ever been produced by human art, nor had the principle of life ever discovered itself to human investigation. Lastly, after a courteous acknowledgment of the services rendered by Darwin to biological science, he reached the point to which all his previous remarks had been tending, proclaimed his personal conviction that the doctrine of natural selection was inadequate to explain the origin of species, and that there was nothing left for us but to fall back on the hypothesis of intelligent and beneficent design as the ruling and guiding principle in the universe.

The end of his lordship's address thus throws light on the beginning. In reality it was an allocution not to the British Association for the Advancement of Science, but to the British public. The British Association did not require to be reminded that the ultimate atom of matter had not yet been discovered, nor that the ether still remained not much more than a working hypothesis, nor that chemical synthesis had not yet compassed the production of a definite living organism. The British public, on the other hand, would find a general declaration of failure on these several lines of research more or less comforting; seeing that, like most other publics in so-called civilized countries, while it is quite prepared to acclaim the results of science when they take the form of cheapened goods or increased conveniences of life, it dearly loves to think that philosophers make blunders and meet with disappointments, and, on the whole, are not so much wiser than other people. Consequently, the communication that was of little value or significance to the learned body to which it was addressed, was of much (misleading) significance to the unlearned body of the public for whom, we can not but believe, it was mainly intended.

In dealing with the doctrine of natural selection his lordship does not seem to us to have been altogether fair. He made as much as possible of the difficul-

ties in the way of its acceptance, but gave no hint of the considerations which have forced it on the belief of nearly all students of zoölogy and biology. In like manner he brought forward the objection urged by Sir William Thompson (now Lord Kelvin) and Prof. Tait, as regards the time-limit fixed by the laws of radiation for the possible existence of life on the earth, and left it to be understood that it was of an altogether insuperable character, which is far from being the case. The greatest disservice, however, which he did to the cause of science was in taking his stand, against the theory of natural selection, upon the doctrine of design. It needs but a few moments of careful and candid consideration to show that the doctrine of design means the death of scientific investigation. If things are so because they were intentionally made so, or because certain processes were miraculously expedited, then the universe may be the theater of Will, but not of forces the operation of which we can hope to understand. It is worthy of remark that his lordship did not even mention the familiar phenomenon of the struggle for life. That is something which can not be denied; and yet nothing is plainer than that the struggle for life means natural selection, and must, under certain circumstances, tend to the formation of new species. Prof. Karl Pearson, discussing this point in the Fortnightly Review for September, well observes that "every man who has lived through a hard winter, every man who has examined a mortality table, every man who has studied the history of nations, has probably seen natural selection at work." Lord Salisbury himself admits that Darwin "has, as a matter of fact, disposed of the doctrine of the immutability of species. . . . Few" (he adds) "are now found to doubt that animals separated by differences far exceeding those that distinguish what we know as species have yet descended from common ancestors." Well, how has this been brought about? Did the Divine Being, by an arbitrary act of will, simply change at a given moment the progeny of a given pair of animals so that one or more new species, or what we call species, should be originated, or was there some natural process of physical causation at work to produce the result? If the former alternative is to be adopted, then, as we have already said, all investigation of causes becomes futile: if the latter, then it matters little whether we accept Darwin's theory or some other; and certainly no one would wish to take his stand on Darwin's theory if a better—one which would fit the facts more closely—were available. The reason why the doctrine of design is so popular is partly because it is such a saver of intellectual toil, and partly because, by making knowledge impossible, it glorifies ignorance. It reduces biology to that "merely statistical" level from which, according to Lord Salisbury himself, it was the glory of Darwin to have raised it. What is left for the student of Nature save to record facts as he finds them, when every question as to how things have come to be as they are receives but the one reply, "The Creator designed them so"?

The unfriendly attitude of Lord Salisbury toward the doctrine of evolution is clearly shown by a remark he dropped when talking about the elements. "If," he said, "they were organic beings, all our difficulties would be solved by muttering the comfortable word 'evolution'—one of those indefinite words from time to time vouchsafed to humanity, which have the gift of alleviating so many perplexities and masking so many gaps in our knowledge." Lord Salisbury was addressing a presumably learned audience: why should men of the caliber of his hearers be disposed to "mutter" the word evolution without regard either to its proper meaning or to its application to the matter in hand? What the unlearned

public would mutter is not much to the point, but it would hardly be the word "evolution." Prof. Pearson, however, in an article already alluded to, furnishes plausible reason, as other writers before him have done, for holding that "evolution" might be a very pertinent word not to mutter, but to utter, in connection with the very question his lordship had in view, and certainly a better word than "design." Lord Salisbury says that, although it is not easy to give a precise logical reason for the feeling, still the feeling is irresistible, that there can not really be sixty-five primordial bodies, but that the facts as cognized by us to-day conceal some much simpler condition of things. Why? If, when we are confronted with the difficulties which beset the origin of species, our duty is to fall back upon the doctrine of design, why should we not equally fall back on that doctrine when confronted with a seemingly ridiculous number of elements? It is very difficult to see why dogma should interfere to cut off one line of investigation and not another. Is it because Lord Salisbury is chiefly interested in physical studies that he repudiates for them the fetters he is only too willing to impose on biology? It would almost seem so; but if he is not impious in wishing to free physics from all dogmatic entanglements, neither is the biologist who desires and claims as much for the study of his choice.

It is too late to try to turn men aside from the unfettered, unbiased pursuit of natural knowledge. The method that Lord Salisbury prescribes for the students of organic Nature has been abundantly tried in the past and been found abundantly unfruitful. The more excellent way which Darwin has shown has, according to Lord Salisbury's own confession, already fertilized wide fields of knowledge; and its impulse and efficacy are far as yet from being exhausted. Darwin never supposed that he had furnished a key to all the mysteries of organic Nature, nor do the wiser of his followers entertain any such notion to-day. If some are foolish enough to think so, they will become wiser in time; but better far is it to place undue faith in a definite physical principle than, abandoning the search for causes, to adopt an arbitrary and stereotyped explanation which raises a barrier to all further intellectual advance.

POPULIST LOGIC.

A Missouri paper of the "Populist" faith predicts that when the state assumes control of the railways—which it says is but a question of time and a very short time at that—"the employees will be well paid, and we will hear no more of strikes and boycotts, while the great mass of the people who patronize the roads will for the first time know how little it actually costs to transport persons, products, and intelligence." As an instance of how cheaply the Government can do things, it cites the fact that a newspaper publisher can send one hundred pounds weight of his papers all over the country by post, and have them delivered, say, to twelve hundred different persons, for one dollar—a charge, it goes on to say, which is found "ample to meet all expenses." It is a great pity that journals which profess to deal with facts, and especially those which, from a basis of supposed facts, venture to draw most important and sweeping conclusions, do not take a little more trouble to state things correctly. What evidence is there, we would ask, that one cent per pound postage on newspapers is a paying rate? It is not to be found in the Postmaster General's report, which shows for the year 1893 a deficit of $5,177,171. This deficit arises on the whole business of the Post Office, which includes the carrying of letters at the rate of about fifty cents a pound; so that, could this part of the business, which undoubtedly yields a profit, be separated from the carrying of inferior

grades of matter, the deficit arising on the latter would be vastly greater than that shown by the general balance sheet. Again, could newspaper matter paying only a cent a pound in bulk be separated from matter paying one cent per ounce, one cent per two ounces, and one cent per four ounces, it would still more clearly be seen at what an enormous loss the conveying of newspapers at the rate mentioned is carried on. It is too bad that people should be imposed on in this way; they support a paper specially to defend their interests, and it does so by feeding them with sophistry and misinformation. That is not the way to bring on the millennium.

THEOSOPHIST LOGIC NO BETTER.

In the August number of the Nineteenth Century a leading theosophist writer, Mr. A. P. Sinnett, undertakes to explain to us by an analogy the position of superiority which persons who are theosophically enlightened enjoy with reference to those who use only their ordinary senses and faculties. Conceive, he says, that mankind at large, while sensitive to light and shade, possessed no sense for color, but that a certain number of individuals were endowed with such a sense: the result would be that the latter would be regarded by the great majority "as guilty (to say the least) of a very gross affectation in professing to regard the tints of a flower as more agreeable to the eye than the color of a lump of clay." If the color-distinguishing minority were to go a step further and profess to be able to distinguish claret from sherry by simply looking at them, they would offend, we are told, still more deeply the common sense of the majority and would create doubt "as to the healthiness of their understanding."

It is indeed, we must confess, very difficult to have full confidence in the healthiness of the understanding of a writer who tries to palm off upon us an argument of this kind. In the case supposed the persons possessing the more-developed faculty would demonstrate every day of life, and in matters coming within the cognizance of all, that they had a definite power not possessed by men in general; and, instead of offending the common sense of the majority, they would be in high honor, and would have their choice of lucrative employments. But if these persons merely professed to have a sense, and now made a hit and now a miss, but far more often a miss than a hit in the pretended application of it, and if they charged money for their exercises in guess work they would make some dupes, but they would certainly offend both the common sense and the common honesty of right-thinking people. We venture to say in the most positive manner that theosophists can do nothing whatever parallel, in the world as it is to-day, to the distinguishing of colors in a color-blind community. If they can, tests can be made anywhere and everywhere, before any class of persons, with equal and unvarying success. The person who could distinguish claret from sherry by the color could go on doing it all day long, and it would not matter in the least to him before whom he exercised the power. He would do it so infallibly, so unvaryingly, and under such every-day conditions, that the non-recognition of his possession of a special faculty would be out of the question. But is there any theosophist to-day who, as theosophist, can claim to be able so much as to play an unvaryingly successful game of poker, to take a most familiar, and we hope not too vulgar, illustration? If there is, a grand career is open to him in some of our social circles. But Mr. Sinnett makes no such claim for his co-religionists. He goes no further than to say that, "although still a minority as compared with the whole, those persons who exercise what occult students generally call the 'astral

senses' in varying degrees, are sufficiently numerous *to confirm one another's observations and reports.*" The Italics are ours. Here we have the whole case. Reducing it to the terms of the former illustration, instead of the persons claiming to be endowed with the color-sense being in a position to experiment before the whole world in the distinguishing by sight of claret from sherry and other similar feats, they simply form a clique who perform experiments in more or less secret conclave, and then profess "to confirm one another's observations and reports." The two things are very different. Mr. Sinnett had better have chosen a different illustration.

LITERARY NOTICES.

COLLECTED ESSAYS. By T. H. HUXLEY. Vol. VI. Hume, with Helps to the Study of Berkeley. Pp. 319. Vol. VII. Man's Place in Nature, and other Anthropological Essays. Pp. 328. Vol. VIII. Discourses, Biological and Geological. Pp. 388. New York: D. Appleton & Co. Price, $1.25 each.

IN the preface to the first of these volumes Prof. Huxley repeats his conviction, often expressed, that Descartes, if any one, may claim to be the father of modern philosophy; or that his general scheme of things, his conceptions of scientific method, and of the conditions and limits of certainty are far more essentially and characteristically modern than those of any of his immdiate predecessors and successors. A ruling axiom in his work, obedience to which was the source of his great merit—and an axiom which seems, moreover, to have inspired Prof. Huxley in all his studies—was expressed in his famous resolution "to take nothing for truth without clear knowledge that it is such"; "the great practical effect of which," says the author, "is the sanctification of doubt; the recognition that the profession of belief in propositions, of the truth of which there is no sufficient evidence, is immoral; the discrowning of authority as such; the repudiation of the confusion, beloved of sophists of all sorts, between free assent and mere piously gagged dissent; and the admission of the obligation to reconsider even one's axioms on demand." In the reform of philosophy since Descartes, Prof. Huxley thinks he finds the greatest and most fruitful results of the activity of the modern spirit, perhaps the only great and lasting results, in those first presented in the works of Hume and Berkeley, one of whom carried out the Cartesian principle to its logical result, and the other extended the Cartesian criticism to the whole range of propositions commonly "taken for truth." The essay on Hume was prepared originally for the English Men of Letters series, with some hope of passing on to others the benefits the author had received from the study of his works. The author hoped, also, at one time to add an analogous exposition of Berkeley's views, but was unable to carry out his desire, and is forced to content himself with giving two preliminary studies.

The first three essays in Man's Place in Nature recall an incident in the history of science, when, thirty-seven years ago, Prof. Huxley, after due study of the subject, ventured to differ with his fellow zoölogists or anthropologists, and to maintain that so far from certain features of the brain being peculiar to man and separating him far from other mammals, they were shared by him with all the higher and many of the lower apes. The rash philosopher was helped, to some extent, out of the troubles this indiscreet assertion brought upon him by the appearance of Darwin's Origin of Species. In 1860 he delivered six lectures to workingmen on the Relation of Man to the Lower Animals, and the subject was discussed before a "jury of experts" at the Oxford meeting of the British Association; and in 1862 Sir W. Flower publicly demonstrated the existence in apes of those cerebral characters which had been said to be peculiar to man. Besides the three lectures, first published in their present form in 1863, which embody the principles about which controversy raged, the volume contains lectures on the Methods and Results of Ethnology (1865), Some Fixed Points in British Ethnology (1871), and The Aryan Question (1890).

In the third of the volumes the author declares that he has never been able to regard a popular lecture as a mere side-work, unworthy of being ranked among the serious ef-

forts of a philosopher, and is not one of those "who keep their fame as scientific hierophants unsullied by attempts—at least of the successful sort—to be understanded of the people"; but has found that the task of putting the truths learned in the field, the laboratory, and the museum, into language which, "without bating a jot of scientific accuracy," shall be generally intelligible, taxed such scientific and literary faculty as he possessed to the uttermost. Yet the popularization of science has its drawbacks, and success in it has its perils for those who succeed. "The 'people who fail' take their revenge, . . . by ignoring all the rest of a man's work and glibly labeling him a mere popularizer. If the falsehood were not too glaring, they would say the same of Faraday and Helmholtz and Kelvin." The volume contains eleven lectures, among which are some considering the origin and beginnings of life and the date of the beginnings, and involving the questions concerning which the biologists and the physicists are at odds. In literary style these essays are fit to rank among the most vigorous and idiomatic examples of English expression.

A Treatise on Astronomical Spectroscopy. Being a Translation of Die Spectralanalyse der Gestirne. By Prof. Dr. J. Scheiner. Translated, revised, and enlarged by Edwin Brant Frost. Boston: Ginn & Co. Pp. 482, with Plates. Price, $5.

This book was prepared in the original German because, although the astronomical was one of the most important applications of spectrum analysis, no suitable text-book was found especially devoted to it; the popular works, like Schellen's, admirable as they were within their range, were not suitable for the serious study of the subject, nor adapted as handbooks to scientific investigators; and while Kayser's Lehrbuch treated the subject in a more scientific way, it dealt with celestial spectroscopy in too brief and incidental a manner. The author felt, therefore, as the domain of astronomical spectroscopy was widening constantly, an increasing need of a work presenting an exhaustive account of all the modern methods and results of research in this branch of science. For like reasons, and because of the welcome that was given to the book, the translator regarded it as desirable that it should be made more available for instruction in the higher institutions, and more accessible to English-speaking persons interested in astrophysics. The author has endeavored to satisfy the requirements of both practice and theory, while at the same time giving a record of the results thus far accomplished; and, to make it more useful for practical work, has added a number of spectroscopic tables and an ample bibliography. The translator has found the advances in the science during the three years since the original was published so great that much had to be added giving the results of recent observations. As a rule, the portions so added are not distinguished from the original, all that is attempted having been to make the work thoroughly homogeneous and to present the facts and theories as impartially as possible. While this has been done with Prof. Scheiner's consent, he has opinions of his own on some of the points thus added, which he expresses in the preface. The work is divided into four parts, which relate severally to Spectroscopic Apparatus, Spectroscopic Theories, the Results of Spectroscopic Observations, and Spectroscopic Tables.

Great Commanders. General Washington. By General Bradley T. Johnson. New York: D. Appleton & Co. Pp. 338. Price, $1.50.

The author approached the duty of preparing this biography for the Great Commanders Series with much diffidence, because of the multitude of lives of Washington, the industrious authors and translators of which had spared no effort to find all that could be learned about him, so that "no new facts could be adduced to throw light upon his career or his character." Yet he believes that his work is the first attempt to consider the military character of Washington and to write his life as a soldier. While we may admit with General Johnson that the superhuman glamour with which a grateful childnation invested Washington in the years just after the Revolution has fallen away and given place to a more reasonable estimation of him as simply a man of extraordinary virtues, we can not agree with him that any diminution in the general respect for the abilities of the Father of his Country has taken place; and we can not conceive that he has ever been regarded by the American

people as no more than "an honest, well-meaning gentleman, but with no capacity for military and only mediocre ability in civil affairs." His place has never been other than first in the three fields in which the celebrated eulogy gave him that position; and the steady drift toward giving him his proper place in history and his appropriate appreciation as a soldier and statesman which the author acknowledges to have been going on for twenty-five years, was never less constant than it is now. Not words of eulogy, but rational appreciation of facts and calm estimates of deeds and appreciation of the bearing of the statesman's counsels and words constitute the highest admiration; and in these the American people have not been wanting toward Washington. In this work General Johnson has made a welcome contribution to our knowledge of Washington as he was.

MICRO-ORGANISMS IN WATER. Their Significance, Identification, and Removal. By PERCY FRANKLAND and Mrs. PERCY FRANKLAND. New York: Longmans, Green & Co. Pp. 532. Price, $5.

THE purpose of this work is to present in a compact shape the results of investigation of the bacteriology of water, the literature of which is extensive and very much scattered. The authors have therefore endeavored to present in it in connected form an account of the more important work that has been carried on in this department, in the hope that it may be of service to the student, the investigator, and those who are practically concerned with the hygienic aspects of water supply. They give, first, a survey of all the more important general methods of bacteriological study, describing in detail those which are specially applicable to the examination of water; second, an account of the principal results hitherto arrived at by the use of these new bacteriological methods in the study of the different kinds of water, and the changes which they undergo through natural and artificial agencies. Particular attention has also been bestowed on the behavior of pathogenic bacteria in water; and a concise description is appended of the principal characters of all the micro-organisms, numbering more than two hundred, which, so far as the authors have been able to ascertain, have hitherto been found in water. The first chapter treats of sterilization and the preparation of culture media, describing the forms of sterilizing apparatus and the use of them, and giving directions for the preparation of the media, with estimates of their value and particular application. The second chapter is devoted to the staining and microscopic examination of micro-organisms; the third, to the examination of water for micro-organisms. In the fourth and part of the fifth chapters, account is given of the numbers of micro-organisms that are found in waters derived from different sources, as ice, hail, rain, rivers, lakes, etc. The various methods of purifying water for drinking purposes are described and discussed in the fifth chapter. The subjects of the succeeding chapters are the multiplication of micro-organisms; the detection of pathogenic bacteria in water; the vitality of particular pathogenic bacteria in different waters; the action of light on micro-organisms in water and culture mediums; and tabular descriptions, with illustrations, of the various micro-organisms found in water.

HOW GERTRUDE TEACHES HER CHILDREN. By JOHANN HEINRICH PESTALOZZI. Translated by Lucy E. Holland and Francis C. Turner, and edited by Ebenezer Cooke. Syracuse, N. Y.: C. W. Bardeen. Pp. 256. Price, $1.50.

THIS is described on the title-page as an attempt, given in the form of a report to the Society of the Friends of Education at Burgdorf, to help mothers to teach their own children, and an account of the method. But little of it has been translated before, those portions given in Biber's Life of Pestalozzi being, according to the editor, all. There are difficulties in the way of translation, on account of the use of peculiar terms for which there is no adequate English rendering. The translators have tried to give a literal translation without paraphrase and without omissions. They do not regard their work as perfect, and will "gladly and thankfully" receive any help which will make the authors' thought still clearer. The translation is preceded by a biographical and historical introduction. The position of this work is defined by the editor as along with the Method and the First Letter from Stanz, the place of the method being after Letter I of this

book, in which Pestalozzi gives the history and circumstances that led him to those principles which he first definitely stated in the Method. These three essays form a complete group, and are estimated as Pestalozzi's most important educational works.

WOOLEN SPINNING. By CHARLES VICKERMAN. New York: Macmillan & Co. Pp. 352.

THIS work is designed to be a text-book for students in technical schools and colleges, and for skillful practical men in woolen mills, which the author believes has long been wanted. The want is accentuated by the retrograde position into which the woolen industry has drifted during late years. The object of the book is to restate the principles that underlie the various processes and operations of the earlier portions of the woolen manufacture, and to assert their importance from the nature of the material in its raw state onward through every operation up to its being ready for the loom. The special subjects are considered of the nature and qualities of wool, sources of supply, sorting, scouring and drying, bleaching and extracting, dyeing, teasing or willeying, burring, mixing, oiling, carding; spinning, its history, principles, and progress; and the self-actor mule. The text is made clearer by the aid of numerous illustrations.

BIBLE, SCIENCE AND FAITH. By the Rev. J. A. ZAHM. Baltimore: John Murphy & Co. Pp. 316. Price, $1.25.

THE purpose of this book is to discuss the relationship between religion and science, and to prove that there is no antagonism between the truths of the Bible and the truths of Nature as revealed by scientific research. Some of the topics treated were presented before the Catholic summer school in 1893, and excited much interest and discussion. The author recognizes that a more extensive acquaintance with the natural and physical sciences, and the accumulation by Egyptologists and Assyriologists of new historical facts of far-reaching importance, have thrown much light on many parts of the Bible that were previously ill understood, if at all, and have supplied us with the necessary data for the solution of numerous perplexing problems which before were regarded as inexplicable mysteries. The notion is contradicted that reliance upon the Bible as a divinely inspired book should interfere with the freedom of investigation any more than reliance upon the compass or lighthouses should cripple the mariner's freedom of sailing. The truths of faith and the truths of science, though belonging to different categories, can never come into conflict. Both have God for their author. Guided by these views, the author discusses the Mosaic Hexaemeron in the Light of Exegesis and Modern Science (showing in the discussion how St. Gregory of Nyssa foreshadowed the nebular hypothesis and St. Augustine was an evolutionist); the Noachian Deluge, particularly with reference to its geographical, zoölogical, and anthropological universality; and the Age of the Human Race according to Modern Science and Biblical Chronology.

THE NATURAL LAW OF MONEY. By WILLIAM BROUGH. New York: G. P. Putnam's Sons. Pp. 168. Price, $1.

IN this work the successive steps in the growth of money are traced from the days of barter to the introduction of the modern clearing house, and monetary principles are examined in their relation to present and past legislation. It is shown in the beginning that money came into use on account of its inherent fitness for certain services and men's appreciation of its value for such services before laws were made for its regulation and independently of laws. This argument is further developed to show that legal regulation can not, does not, and never did give value to money or affect it in any way save that unwise enactments may limit its elasticity and usefulness. "Clearly there is no need of making coin a legal tender at any weight whatever. If governments would confine their legislation to fixing by enactment the fineness of the precious metal and the number of grains that shall constitute each piece of a given size, they may safely leave the maintenance of the coinage in its integrity and the value of the pieces to be regulated by individual interest and action. Practically this point of monetary advancement has been reached by most of the civilized nations; but in the useless, although comparatively harmless, act of decreeing that coin shall be a legal tender at its bullion worth is manifested the extreme conservatism

which still clings to the old delusion that legislation may in some vague sense regulate the value of coin. Although this delusion is harmless, as now exhibited in coinage acts, it becomes extremely mischievous when the attempt is made to regulate the value of the silver and gold coin at a fixed ratio of weights under the ruling of bimetallism; and it is only in a less degree mischievous when one of the money metals is ejected from the circulation under the ruling of monometallism." The argument is further carried out in chapters on Paper Money and Banking; the Monetary System of Canada; Money, Capital, and Interest; and Mandatory Money and Free Money; and is enforced by citation of The Hoarding Panic of July, 1893, when business found temporary relief from embarrassment in a method of its own spontaneous devising independent of legislative enactments.

THE STEAM ENGINE AND OTHER HEAT ENGINES. By J. A. EWING. New York: Macmillan & Co. Pp. 400. Price, $3.75.

THE author of this work is also author of the article on the same subject in the Encyclopædia Britannica. Starting to expand that article into a university text-book, the additions and changes became so considerable that a virtually new work, except for parts of one or two chapters, was the result of the effort. The design has been to treat, besides the thermo-dynamics of the steam engine, of other aspects of the subject that admit of theoretical discussion, such as the kinematics of the slide valve and the kinetics of the governor and of the moving mechanism as a whole, and to give a general, if brief, account of the forms taken by actual engines and of the manner of their working. No attempt has been made to describe details particularly, but the distinguishing features of certain types have been indicated. In doing this, the greatest amount of space has been given to the less familiar forms, on the principle that a student need be at no loss to learn the construction of engines of the commoner kinds. Under "other heat engines" are included air, gas, and oil engines. The author has endeavored throughout to make evident the bearing of theory on practical issues; and the experimental study of steam engines is described at some length. In the course of the work are reviewed the Early History of the Steam Engine, the Elementary Theory of Heat Engines, the Properties of Steam and the Elementary Theory of the Steam Engine, the Behavior of Steam in the Cylinder, the Testing of Steam Engines, Compound Expansion, Valves and Valve Gears, Governing, the Work of the Crank Shaft, Boilers, Forms of the Steam Engine, and air, gas, and oil engines.

PAPERS AND NOTES ON THE GLACIAL GEOLOGY OF GREAT BRITAIN AND IRELAND. By the late HENRY CARVILL LEWIS, M. A., F. G. S. Edited from his unpublished MSS., with an introduction by Henry W. Crosskey, LL. D., F. G. S. London and New York: Longmans, Green & Co. Pp. 469.

HAD Carvill Lewis lived the ordinary span of life, the problem of the glacial deposits would have been pushed well toward solution by his efforts. One is fully convinced of this by an examination of the materials and the observations upon them accumulated by him which are now given to the public. His energy and ability are evident in his unfinished work, and, being thoroughly acquainted with geological principles and having the means to devote himself to his chosen researches, he would undoubtedly have accomplished important results. His last labors were done upon the glacial deposits of the British Isles. The whole of Scotland, nearly the whole of Ireland and Wales, and the northern part of England are included in the glaciated area of those islands. The volume before us opens with introductions by Dr. Crosskey and Mrs. Lewis, then follow five papers on various phases of the general subject. The greater part of the volume is made up of Prof. Lewis's field note books, which embody his observations made in the several glaciated counties of England and in Ireland during a visit in 1885 and another in 1886. Some field notes made in Switzerland, Italy, Germany, Belgium, and Holland are given in an appendix. From these materials we can derive Lewis's theory of glaciers as it was when his labors ceased. Not all glacialists will agree with it, for there are wide differences of opinion upon glacial theory. There is not even agreement as to matters of observation. But every one must admit that his hypothesis is clear and consistent, and requires no extrava-

gant assumptions. It conceives the ancient ice sheet as formed thus: From many groups of mountains there radiate glaciers which meet and unite, but do not entirely lose their individualities. Each may be traced in its course by the nature of the stones which it carries, and the furthest advance of each will be marked by a terminal moraine. These glaciers would frequently form lakes by damming rivers, and the lakes would make deposits which must be distinguished from those dropped by the ice. The former he calls bowlder clay and the latter till. Many earlier theories and beliefs are vigorously shaken up in these notes. In the freely expressed opinions jotted down, in its evidence of the forming and abandonment or modification and development of views, this volume has a peculiar value that a finished treatise would not have. The investigator who would carry this subject forward should read the posthumous contribution of Prof. Lewis carefully and often.

ESSAYS IN HISTORICAL CHEMISTRY. By T. E. THORPE, Sc. D., F. R. S. London and New York: Macmillan & Co. Pp. 381. Price, $2.25.

IN the dozen or so of lectures and addresses which Prof. Thorpe has gathered into this volume he tells how most of the great chemical discoveries of the past two hundred and fifty years have been made, and gives us an acquaintance with the personalities of the men who made them. The lectures are arranged in historical sequence, the first sketching the life and work of Robert Boyle, and the others dealing successively with Priestley, Scheele, Cavendish, Lavoisier, Faraday, Graham, Wöhler, Dumas, Kopp, and Mendeleeff. In this volume we may read how oxygen and the composition of water were discovered, and what were the respective shares of Priestley, Cavendish, and Lavoisier in these discoveries; how Wöhler broke down the barrier between organic and inorganic chemistry, and how the wonderful Russian, Mendeleeff, evolved the periodic arrangement of the elements. We may, moreover, learn also that Cavendish was intensely shy, a hater of noise and bustle, and had a house made up of laboratories and workshops, very little of it being set apart for personal comfort; that when young Faraday was traveling on the Continent as amanuensis to Sir Humphry Davy he wrote of Lady Davy, "Her temper makes it oftentimes go wrong with me, with herself, and with Sir Humphry," and similar interesting facts about the other men included in the volume. The lectures have been delivered as occasion has called them forth, to a variety of audiences, and the author is far from claiming that they constitute a history of the time from Boyle to the present day.

AN INTRODUCTION TO THE STUDY OF SOCIETY. By ALBION W. SMALL, Ph. D., and GEORGE E. VINCENT. American Book Company. Pp. 384. Price, $1.80.

THE inquiry for a syllabus of sociological method printed in 1889 by one of the authors of this manual furnished surprising evidence of demand for scientific exposition of social relations. The interest in philosophical sociology has continued to increase in this country. Since the organization of the Department of Sociology in the University of Chicago applications for information about a suitable text-book of the subject have been incessant. No such text-book existing, this manual has been prepared as a guide to the elementary study. It does not presume to be a contribution to sociological knowledge or a report of research on the material of social knowledge, but a help in the training of beginners, the proposal of a method of preliminary investigation, a "laboratory guide"; the outgrowth of experience in teaching sociology under difficulties. It aims to commend a method that shall emphasize the necessity of precise knowledge of social facts, and shall confirm students in the habit of widening their comprehension of particulars by relating them to the containing conditions. The first book, on the Origin and Scope of Sociology, starts with the beginnings of the science, and goes on to treat of its development, its relation to the special social sciences and to social reforms, and of the organic conception of sociology. The second book, on the Natural History of a Society, takes the family, composed of the man and his newly married wife going to open a farm and settle on the native, solitary prairie, and traces the gradual growth of the community through the increase of the family, the accession of new settlers, the beginning of

local trade, the constitution of the village and its development by the organization and division of industries, the establishment of communications, the formation of various social groups, and all the processes of commercial and municipal growth into the town and the city. The third book concerns social anatomy and the analysis of the elements and factors in the development described in the preceding book; the fourth book, the physiology and pathology of society; and the fifth book, its psychology. The essay is illustrated by five maps and charts delineating the several stages of the growth of the social organization.

PROGRESS IN FLYING MACHINES. By O. CHANUTE, C. E. The American Engineer and Railroad Journal, 47 Cedar Street, New York. Pp. 308. Price, $2.50.

THE subject of aërial navigation has become quite prominent of late by reason of important advances in this field that have been made during the past few years. The idea of controlling the course of a great bag of gas through the currents of the atmosphere has been well-nigh abandoned, and reliance is being placed more and more upon mechanical motors, the buoyancy of the air as exerted under large horizontal surfaces, and the force of the wind. Flying machines are now deemed much more practicable than dirigible balloons. Mr. Chanute's book consists of a series of illustrated articles contributed to The Railroad and Engineering Journal, the chief aims of which were to show whether or not man-flight is possible; to save waste of effort on the part of experimenters by making known what forms of apparatus have failed; and to enable investigators to judge as to whether new machines that may be proposed in future are worthy of trial. The author divides flying machines into three classes: (*a*) Wings and parachutes; (*b*) screws to lift and propel; (*c*) aëroplanes. Flapping wings in imitation of those of birds were early tried, and Mr. Chanute describes many curious forms of them, the earliest authenticated proposal being credited to Leonardo da Vinci. The first known proposal for an aërial screw was also his. Aëroplanes, however, do not date back much before the middle of the present century. Like the first-mentioned class of machines, their principle is derived from an action of birds—in this case the soaring or sailing action. Most of the flying machines described are shown in simple drawings. The results attained by Maxim, Lilienthal, and other recent experimenters are given, the book having been held back from the binder to append Lilienthal's own account of his latest work.

Six General Laws of Nature (*a New Idealism*) is a compendium, by *Solomon J. Silberstein*, of a large work which he contemplates publishing, on Divinity and the Cosmos. It is intended to contain "the primitive cause of force and matter, an explanation of all the physical phenomena in the actuality of the universe, and an attack on the modern scientists and philosophers." The author has satisfied himself by careful analysis that all the systems of philosophy are incomplete, unsatisfactory, and insufficient to the deep, logical, and honest thinker, and that most of the laws or axioms in modern natural science are very often defective, and even false. He therefore issues this work in correction of these errors, with the arguments and demonstrations through which he believes he has discovered the mystery and explained the physical phenomena of Nature.

The fields of biology and physics meet in the *Investigations on Microscopic Foams and on Protoplasm*, by Prof. *O. Bütschli*, of Heidelberg, which has recently appeared in an English translation (A. & C. Black, London, $6.25). Protoplasm is conceived of in this work as having the structure of a froth or foam in which minute droplets of a watery liquid take the place of air in the bubbles of an ordinary foam. The author has carefully investigated this structure in an effort to throw light upon the physical conditions of the phenomena of life. He has imitated it in oil foams and studied the phenomena of these, and has also investigated the structure of protoplasm in various organisms. About half the work is devoted to a summary of the views of other investigators upon the structure of protoplasm. The volume contains a list of works referred to, an index, twelve lithographic plates, and a number of figures in the text.

In preparing a series of essays on *The Relation of Biology to Geological Investigation*

(United States National Museum), Dr. *Charles A. White* had in view, among several objects, a further presentation of elementary matter pertaining to biological geology than has heretofore been published, the defense of biology as an indispensable aid in geological investigation, the repudiation of certain untenable claims that have been made in its favor, an application of the principles discussed to the practical work of the geologist, and the demonstration of the necessity of the preservation of fossil remains in public museums as storehouses of evidence upon geological questions.

How to Build Dynamo-Electric Machinery, by *Edward Trevert*, is intended to be a practical treatise, and in no way to be considered technical. Some theory, however, is given to help the reader in a general way. Its purpose is to give directions for building small dynamos and motors, accompanied by working drawings which will enable the reader to understand the text more clearly. The machines described have been carefully selected for efficiency and beauty of form and as being easy to build. Chapters on commercial dynamos and motors are added to show the general construction of large machines; and chapters on management, armature winding, and field-magnet winding, and a chapter of useful tables are inserted. The machines described are all American. (Published by the Bubier Publishing Company, Lynn, Mass. Price, $2.50.)

In *Hydraulic Power and Hydraulic Machinery* (J. B. Lippincott Co., American publishers) Henry Robinson has drawn from his own practice and utilized the experience of others, as reported in the proceedings of various professional societies, to record, in a form convenient for reference, existing experience in the engineering of water-pressure machinery. Special attention is given to the subject of the flow of water under pressure and to the employment of water-pressure mains to transmit power through the streets of a town on the principle which the author terms "power co-operation." Since the first edition was published, in 1886, the author has had constantly in view the desirability of enlarging and improving it. The present, second, edition is the outcome of this desire and contains much new matter, with better treatment of the old. Some compression, both of subjects and of descriptions, has been necessary to accomplish this, but the author thinks the illustrations selected of the innumerable applications of hydraulic power will be considered fairly to meet the circumstances.

PUBLICATIONS RECEIVED.

Agricultural Experiment Stations. Bulletins and Reports. Iowa Agricultural College, Nos. 24 and 25. Thirteen articles on various subjects Pp. 60 and 48.—Massachusetts: Commercial Fertilizers. Pp. 8.—Michigan State Agricultural College: Fertilizer Analyses, by R. C. Kedzie. Pp. 17. —New York: Analyses of Commercial Fertilizers. Pp. 56.—North Dakota: Weather and Crop Service, July. Pp. 15.—Purdue University: Wheat. Pp. 24. Commercial Fertilizers. Pp. 11, with Table.

American Association. Twelfth Annual Report of the Committee on Indexing Chemical Literature. Pp. 4.

American Chemical Society. Journal. September, 1894. Monthly. Edward Hart, Editor. Easton, Pa.: Chemical Publishing Company. Pp. 72. $5 a year.

American Historical Register, September, 1894. C. H. Browning, Editor in Chief.

Barrett, John P. Electricity at the Columbian Exposition. Chicago: R. R. Donnelly & Sons Company. Pp. 501.

Bech-Meyer, Nico. A Story from Pulmantown. Chicago: Charles H. Kerr & Co. Pp. 110. 25 cents.

Boaz, Franz. Address, Section of Anthropology, American Association. Pp. 29.

Brunache, P. Le Centre de l'Afrique, autour du Tchad (The Center of Africa, around the Tchad). Paris: Félix Alcan. Pp. 349, with Map. 6 francs.

Butler, George P. School English. American Book Company. Pp. 272. 75 cents.

Carus, Dr. Paul. Fundamental Problems. Chicago: The Open Court Publishing Company. Pp. 373. 50 cents.

Cope, E. D. Third Addition to the Knowledge of the Batrachia and Reptilia of Costa Rica. Pp. 12.

Dunham, W. R., M. D. The Science of Vital Force. Boston: Damrell & Upham. Pp. 198.

Dwight, Thomas, M. D., Harvard University. The Range and Significance of Variation in the Human Skeleton. Pp. 29.

Fiske, John. A History of the United States for Schools. Houghton, Mifflin & Co. Pp. 474. $1.

Geologic Atlas of the United States. Ringgold Folio, Georgia-Tennessee, six sheets.—Placerville Folio, California, five sheets.—Livingston Folio, Montana, six sheets. Library edition. Washington: U. S. Geological Survey.

Grimsley, G. P., Columbus, Ohio. The Granites of Cecil County, Maryland. Pp. 50.

Grotenfelt, Gösta; Woll, F. W., American Editor. The Principles of Modern Dairy Practice from a Bacteriological Point of View. New York: John Wiley & Sons. Pp. 283. $2.

Hancock, Joseph L. Ornithophilous Pollination. Pp. 5. with Plate.

Hunt, E. Geometry for Grammar Schools. Boston: D. C. Heath & Co. Pp. 100.

Interstate Commerce Commission. Sixth Annual Report of the condition of the Railways of the United States for the Year ending June 30, 1893. Washington.

Kunz, George F. Natal Stones. Sentiments and Superstitions connected with Precious Stones. New York: Tiffany & Co. Pp. 17.

Lefèvre, André. Race and Language. New York: D. Appleton & Co. Pp. 424. $1.50.

Massachusetts. Third Annual Report of the Trustees of Public Reservations. Pp. 56.

Michigan Mining School, Houghton. Catalogue, 1893-'94. Pp. 215, with Maps.

National Editorial Association. Souvenir of the Banquet tendered to it by F. W. Harper.

New York: State Reformatory at Elmira. Eighteenth Year Book. Pp. 189.—University Regents' Bulletins. No. 27. Extension Teaching. Pp. 72.—No. 28. University Convocation. Pp. 275.—No. 29. Extension Schools. Pp. 84.

Nichols, Edward L. A Laboratory Manual of Physics and Applied Electricity. Vol. II. Macmillan & Co. Pp. 438, with Chart $3.25.

North Dakota Weather Service. First Annual Report. B. H. Bronson, Observer. Pp. 70.

Palmer, Walter K. Mechanical Drawing. Columbus, Ohio: Charles B. Palmer. Pp. 51.

Parker, John D. Historical Paper of the Western Scientific Associations. Pp. 8.

Planetary Publishing Company, Chicago. The Play of the Planets. A Game, with Book. $1.

Powell, J. W., Director of the United States Geological Survey. Tenth and Eleventh Annual Reports of the Bureau of Ethnology. Pp. 822 and 553. Washington: Government Printing Office.

Richter, Eugene. Pictures of the Future. New York: Optimus Printing Company. Pp. 190. 50 cents.

Shinn, Millicent Washburn. Notes on the Development of a Child. University of California Studies. Vol. I, Nos. 1 and 2. Berkeley. Pp. 178.

Smithsonian Institution. Annual Report of the Board of Regents to July, 1893. Washington. Pp. 763.

Storer, F. H., and Lindsay, W. B. An Elementary Manual of Chemistry. American Book Company. Pp. 453. $1.20.

Turner, J. B. The New American Church. Chicago: B. F. Underwood. Pp. 60. 25 cents.

Van Norden, Charles. The Psychic Factor. New York: D. Appleton & Co. Pp. 223. $1.25.

POPULAR MISCELLANY.

Geology at the Brooklyn Meetings.—The Geological Society of America held its sixth summer meeting in Brooklyn, N. Y., August 13th to 15th; and the forty-third annual meeting of the American Association for the Advancement of Science was held in the same city, August 15th to 22d. The number of papers presented before the Geological Society was twenty-six, and exactly the same number also were read before Section E (Geology and Geography) of the association. This year a few distinctly geographical papers were presented in Section E, notably in contrast with several years preceding, which have had almost exclusively geological papers. One especially timely subject was the Geographic Development of China, Corea, and Japan, by Hon. Gardiner G. Hubbard, President of the National Geographic Society, Washington, D. C. On account of the importance and increase of work for both geology and geography, it is proposed that a special section of the association be devoted to each.

The vice-presidential address of Prof. Samuel Calvin, before Section E, on The Niobrara Chalk, called attention to the extensive beds of chalk in the middle division of the Cretaceous series of the upper Missouri River region. It has been generally taught in our geological text-books that no true chalk deposits exist in America; but explorations along the Missouri show that strata of chalk, ranging from sixty to ninety feet in thickness, extend from the mouth of the Niobrara to that of the Sioux River, on the west boundary of Iowa. The best outcrops are near Saint Helena, Nebraska. Microscopic examination reveals the same forms of foraminifera, coccoliths, and rhabdoliths which make up the chalk of England and portions of continental Europe. The close identity of conditions in these two widely separated regions was commented on as a fact of great scientific interest. At the same time with the deposition of the much thicker European chalk-beds, far away to the West, beyond the ninetieth meridian, and thus distant more than a quarter of the way around the globe, with an intervening abysmal ocean and a continental mass of land between these areas, there was another clear sea in which the same or very similar microscopic types of life were developed in incomprehensible profusion to make the chalk-beds of Iowa, South Dakota, and Nebraska.

Papers on the Archæan and Palæozoic rocks were presented by J. F. Kemp, C. H. Smyth, Jr., R. S. Tarr, W. P. Blake, E. O. Hovey, N. H. Darton, Arthur Winslow, C. W. Hall and F. W. Sardeson, C. H. Gordon, C. S. Prosser, N. H. Winchell, and J. P. Smith. Several papers relating to the Mesozoic and Tertiary formations were by H. W. Fairbanks, J. P. Smith, W. H. Dall, and Arthur Hollick. Dr. Dall confirms the Miocene age of the brightly colored and highly inclined fossiliferous strata of Gay Head, at the west end of Martha's Vineyard. Above the Miocene beds, however, and unconformable both with them and the overlying glacial drift, is a fossiliferous horizon of Pliocene age.

The large share of attention which is now being given to the Quaternary era, compris-

ing the Glacial and Recent periods, is marked by the number of papers—eight before the Geological Society, and an equal number before the association, which pertained to this latest geologic era. Among these, perhaps the most notable was by Arthur Hollick, on the disturbance of the Cretaceous and Tertiary clay and sand strata next beneath the glacial drift along the course of the terminal moraine in northern New Jersey, on Staten and Long Islands, Martha's Vineyard, and Nantucket. The crumpled and distorted condition of these beds he ascribed to the crushing force of the ice advance. The dislocations and tilting are of similar character with the disturbances which have been shown to have resulted from the thrust of the Scandinavian ice sheet on the islands of Möen and Rügen in the Baltic Sea.

The recession of the ice sheet from the region of the Great Lakes tributary to the St. Lawrence was discussed in a paper by Warren Upham, tracing the successive stages of the ice-dammed lakes of that region, as known by their beaches, far above the present lake shores. From the relationship of those glacial lakes, held by the barrier of the waning ice sheet on their north and northeast sides, it was shown that the ice sheet in its retreat was melted away from the northern borders of the United States west of Lake Ontario somewhat earlier than from New York and New England. The measure of the Postglacial or Recent period, from the end of the Ice age until now, was thought from the rate of erosion of the gorge below Niagara Falls to have been about seven thousand years. Prof. J. W. Spencer, however, in another paper argued that the duration of this period has been some thirty thousand years.

Prof. Spencer also read a paper on the late Tertiary and Quaternary changes of level of the West Indies, in which great movements of uplift and depression of Cuba and the adjacent Antilles were held to have united these islands repeatedly to the North and South American continents, while the Gulf of Mexico and the Caribbean Sea were connected with the Pacific Ocean.

The Quaternary history of the Mississippi Valley was considered by Oscar H. Hershey, who regarded the loess of Illinois, Iowa, and the States farther south as the deposit of a somewhat late stage of the Glacial period.

Prof. Calvin's address is published in full in the American Geologist for September; most of the Geological Society's papers will soon be issued in its Bulletin, and abstracts of the association papers will appear, probably about a year hence, in the Proceedings of this meeting.

Officers of the American Association.—The following officers of the American Association have been elected for next year: President, E. W. Morley, Cleveland, Ohio. Vice-Presidents: A, Mathematics and Astronomy, E. S. Holden, Lick Observatory, Cal.; B, Physics, W. Leconte Stevens, Troy, N. Y.; C, Chemistry, William McMurtrie, Troy, N. Y.; D, Mechanical Science and Engineering, William Kent, Passaic, N. J.; E, Geology and Geography, Jed. Hotchkiss, Staunton, Va.; F, Zoölogy, D. S. Jordan, Palo Alto, Cal.; G, Botany, J. C. Arthur, Lafayette, Ind.; H, Anthropology, F. H. Cushing, Washington, D. C.; I, Economic Science and Statistics, B. E. Fernow, Washington, D. C. Permanent Secretary, F. W. Putnam, Cambridge, Mass. General Secretary, James Lewis Howe, Louisville, Ky. Secretary of Council, Charles R. Barnes, Madison, Wis. Treasurer, R. S. Woodward, New York. Secretaries of Sections: A, E. H. Moore, Chicago, Ill.; B, E. Merritt, Ithaca, N. Y.; C, William P. Mason, Troy, N. Y.; D, H. S. Jacoby, Ithaca, N. Y.; E, J. Perrin Smith, Palo Alto, Cal.; F, S. A. Forbes, Champaign, Ill.; G, B. T. Galloway, Washington, D. C.; H, Mrs. Anita Newcombe McGee, Washington, D. C.; I, E. A. Ross, Palo Alto, Cal. The association decided to meet next year in San Francisco, Cal., provided acceptable terms were secured from the railroads.

The Falling of the Leaves.—According to a paper by Prof. Trelease, quoted in Garden and Forest, three more or less distinct periods are observable in the falling of the leaves. The first, occurring on an average a week earlier than the main fall, is marked by the loss of the leaves of weakly twigs; the second comprises the main defoliation; the third embraces the period during which straggling leaves, mostly on branches that have been shaded during the growing season,

successively disappear. This period is often limited only by the beginning of growth the next spring. Most leaves fall in consequence of the formation of a distinct joint, usually at the base of the leaf stalk. In very many of our trees the weakened twigs also are annually cast off by a similar process. This is especially observable in the willows, which are often spoken of as having brittle branches, although their wood is tough except where the joints referred to occur. The cottonwood and white elm show the same peculiarity well, the joints being formed at the beginning of the year's growth, so that the growth of from one to seven or eight years is often pruned off by a gale in autumn; and it is observable on oaks and many other trees. There seem to be two reasons for this provision: The fallen twigs of species that grow in wet places have been observed to strike root, thus serving as natural cuttings for the propagation of the species; on the other hand, it is clearly an advantage to the tree to lose weak branches that would make at best but a poor growth, while shedding and otherwise interfering with the development of the stronger shoots.

Standards for Professional Schools.—President Eliot, of Harvard University, in a recent address before the New England Association of College and Preparatory Schools, pointed out as one of the evils of the present system of management the fact that the requirements for admission to the scientific, technological, and agricultural schools of the country are, as they always have been, much lower than are exacted by the classical colleges. It is another evil that the schools of law and medicine have been, as a rule, "wide open to anybody walking into them from the street, without passing any admission examination whatever, or submitting to any inquiry into previous academic training. . . . This is the condition we have to confront: Three grades of attainment are required for the three different classes of institutions for the higher education—the colleges have the best grade, the scientific schools the next best, and the schools of law and medicine the lowest." The feasibility of finding a remedy for these conditions is held to be largely dependent on the colleges, scientific schools, and secondary schools co-operating. "Imagine the nine principal subjects, represented in these nine conferences" (which are held within the association), "actually put on an equality with each other in seriousness, dignity, and disciplinary value; and imagine a great variety of four-years' courses, all made up from the schedule of the combined conference recommendations, and carried out in hundreds of high schools and academies. Should it make any difference to a college whether a given candidate for admission to the college had studied this set of four or five subjects recommended by the conferences for a four-years' course, or that set of four or five subjects, both sets being taught in the manner recommended by the conferences? Should it make any difference whether the candidate for admission presented—to state the case in an extreme way—Latin, Greek, English, French, and German, or mathematics, physics, natural history, and history? Clearly, if the recommendations of the conferences had been effectively carried out, the education received by the youth who had taken the first group should be just as good as that of the youth who had taken the second group. . . . I need not say that we are not in sight of such a condition of things now. Most of you are perfectly familiar with the kind of substitute which is now offered to a boy in a high school for the classical course, which consists of Latin, Greek, mathematics, with a little history, and possibly the elements of a modern language. The substitute now offered ordinarily consists of English, mathematics, history, geography, botany, zoölogy, astronomy, geology, mineralogy, political economy, ethics, and perhaps the elements of one or two modern languages—an extraordinary number of scraps of miscellaneous subjects, instead of a limited number of substantial subjects, each treated with some thoroughness. Our adverse opinion concerning the possibility of making subjects equal for training value is really founded on our own convictions of the great superiority of the old-fashioned, solid classical programme in the academy and the high school, to the scrappy, ineffective programmes which are substituted for the classical programme in the inferior courses of our high schools and academies. . . . We shall never attain to an equality of subjects until the English or

modern course in secondary schools has been made as solid as the classical. No elementary, superficial, and hasty treatment of a long series of subjects can possibly commend itself to the educated community as likely to produce the good effects of the consecutive, thorough, and prolonged treatment of a smaller group. We shall never know, for example, whether Latin and history are equally well adapted to secure the suitable development of the human mind until we have given history the same chance that we have given Latin."

The Coals of Missouri.—All the coals of Missouri, Mr. Arthur Winslow, State Geologist, informs us, are bituminous, except the cannel coals, which are found in local and small deposits. The bituminous coals have, as a rule, a high percentage of ash, as compared with the best bituminous coals; they are comparatively soft, suffer much from excessive handling or long exposure, and almost always carry pyrites. Most of the mines are less than two hundred feet deep. The Randolph shaft, in Ray County, is four hundred and twenty feet deep to the coal, and is one of the deepest. The deepest operated—which is, exactly speaking, within the State—is near Hamilton, in Caldwell County, and is about five hundred feet deep. At Leavenworth, Kansas, along the State line, however, a coal bed of only twenty-two inches is entensively worked at depths varying from seven hundred to eight hundred feet. For markets, the Western bituminous coal field, of which the Missouri mines are a part, besides the home market, looks chiefly to a great area in Nebraska, Kansas, the Indian Territory, and Texas, which is destitute of coal, and in which the supply of wood is small. Its only competitors are in the deposits of Dakota, Wyoming, Colorado, and New Mexico; but they can furnish only limited supplies.

Sanitary Inspection of Schools.—The English Education Department has started upon a detailed inquiry into the sanitary condition of the schools, and with this purpose has issued forms to the inspectors embodying questions bearing on that subject, to be filled up by them. The thirteen questions relate, for the most part, to the site, structure, and sanitation of the schoolrooms inspected. The inspectors are required, in noting any matters calling for alteration, to press for immediate attention to them, and are given power to use their discretion in enforcing changes. They are also instructed to bring under notice of the managers and the department serious defects in the convenience of the schoolrooms for teaching purposes or in their sanitation, with a view to their immediate removal. The objects of this action are to find, for the purpose of applying adequate means to secure efficiency, how far each existing school falls short of modern requirements, and to furnish a complete statistical record of the condition of school premises throughout the country. Other subjects concerning which inquiry might be made with advantage have been suggested, among which are the lighting of the rooms; the most appropriate closets and their number; the most suitable arrangements for washing—whether basins shall be continued or they shall be done away with and replaced by a stream of running water, affording a means of obviating the danger of communicating parasitic and contagious diseases; and the physical and mental condition of the pupils.

The Lichtenthaler Collection.—Illinois Wesleyan University has obtained by bequest the valuable collection of shells, ferns, and algæ gathered by the late George W. Lichtenthaler, of Bloomington, Ill., which has been placed in its museum as the George W. and Rebecca S. Lichtenthaler collection. It includes shells—between six thousand and eight thousand species, with twenty-five thousand specimens; crustaceans, echinoderms, corallines, corals, fossil shells and plants, minerals, four hundred species of ferns, and eight hundred species of marine algæ. Several cases are filled with gastropod shells cut longitudinally so as to show their spiral structure, and the highly polished specimens are very numerous. The ferns comprise a nearly complete collection of North American species, a complete collection from the Hawaiian Islands, and many from India, China, Japan, Australia, New Zealand, South America, and Europe. Mr. Lichtenthaler, one of the best known of American conchologists, and one of the early

members of the American Association of Conchologists, was born about 1833, and removed to Bloomington, Ill., when twenty-two years old. He retired from business "with a snug fortune" after seventeen years of dealing in drugs. During this time he imbibed a taste for natural history, and after his retirement devoted his entire time and the proceeds of his large estate to the gathering and collecting of specimens. After Mrs. Lichtenthaler's death, without children, about ten years ago, he turned his attention more than ever to his chosen work. He died in San Francisco, Cal., February 20, 1893. He was a true amateur, and never sold a specimen or labored for hire, but was always ready to exchange specimens or give duplicates to persons who would appreciate them. In leaving his collection to the Illinois Wesleyan University he took care that his wife's name should be associated with his in the title given it.

The Giraffe.—The giraffe is described by R. Lydekker as the sole living representative of a separate family of the group of ruminant ungulates. It owes its height mainly to an enormous elongation of two of the bones of the legs, combined with a corresponding lengthening of the vertebræ of the neck. Its long neck has no more vertebræ than the neck of the hippopotamus or the extremely short neck of the whale. But while the bones of the whale and hippopotamus are broad and short, those of the giraffe are long—ten inches in full-grown animals—and slender. Accurate information is wanting as to the extreme height attained by the giraffe, but specimens of seventeen and eighteen feet have been described. The most distinctive structural peculiarity of the animal is in the nature of its horns, which take the form of upright bony projections from the top of the head, wholly covered with skin, and are unlike those of any other living ruminant. The giraffe's place in the animal kingdom seems to be between those of the deer and the antelopes; "while, as neither of these three groups can be regarded as the direct descendant of either of the other two, it is clear that we must regard all three as divergent branches of some ancient common stock." Of external features, the giraffe has not those lateral or spinous hoofs which are present in most ruminants. The large size and prominence of the eyes and the extensibility of the tongue are noticeable features The long tail, terminating in a large tuft of black hairs, is a feature unlike any in the deer, though it recalls certain points in the antelopes. "Somewhat stiff and ungainly in its motions—the small number of vertebræ not admitting the graceful arching of the neck characterizing the swan and the ostrich—the giraffe is in all parts of its organization admirably adapted to a life on open plains dotted over with tall trees, upon which it can browse without fear of competition by any other living creature. Its wide range of vision affords it timely warning of the approach of foes; from the effect of sand-storms it is protected by the power of automatically closing its nostrils; while its capacity of existing for months at a time without drinking renders it suited to inhabit waterless districts." When seen away from its habitual surroundings the spots of the giraffe make it seem very conspicuous; but among the tall mimosas in which they feed, "giraffes are the most inconspicuous of all animals; their mottled coats harmonizing so exactly with the weather-beaten stems and with the splashes of light and shade thrown on the ground by the sun shining through the leaves, that at a comparatively short distance even the Bushman or Caffre is frequently at a total loss to distinguish trees from giraffes or giraffes from trees." The giraffe is now confined to Africa, although in Pliocene times it roamed over parts of southern Europe and Asia. It was known to the Romans of the time of the empire as the camelopard, but was afterward forgotten in Europe till about two hundred years ago. It is much hunted for its skins, which are used in the manufacture of the South African *jambok* whips, and is in great danger of being driven out of existence.

Negative Evidence from the Caves.—In the papers of the department of Archæology and Paleontology of the University of Pennsylvania, H. C. Mercer describes explorations of caves and other spots which might yield signs, near Trenton, N. J., and in the South, for evidences of Palæolithic man. At Trenton he found "turtlebacks," explainable as "inchoate cache blades of the latest Indian

period," and other turtlebacks not so explainable, "and seeming to betoken a period of unknown direction before the working of the quarries." In Durham Cave, Stroudsburg, Pa., instead of a pre-Indian cave man, a red man was found, "as the contemporary, it seemed, of the peccary and giant chinchilla." In the chalk gorges of southern Texas, apparently promising indications gave only tokens of modern surface loam, which had fallen and mingled with ancient underplaced chalk. The cave at Lookout Mountain was explored to the bottom. Teeth of the tapir close to the layer of occupancy by man, added, however, a new species to the list of extinct North American mammals thus far observed in like association with human remains. The Nicajack Cave, in Marion County, Tenn., likewise failed to yield any earlier than neolithic remains.

Kinds of Ivory.—Four principal kinds of ivory are known in the market: that of Guinea, the Gaboon, or Angola, which is a little greenish, so that it is sometimes called green ivory, and which whitens with age; Cape ivory, which is of a dull, light, somewhat yellowish color; Indian or Siamese ivory, very rare, and white, with a tinge of rose color; and the fossil ivory of Siberia, remains of the mammoths of the olden time. Of these, the West African ivory is most highly prized, being finer and more transparent than the others. It is pretended that experts, when they see a well-preserved tusk, can tell whether the animal that wore it came from East or West Africa, or north or south of the equator. The farther north the animal's habitat, and the more elevated and dry the situation, the more the ivory is coarse and inferior. The principal market for ivory is at Liverpool, and nearly one third of the stock imported there is used in the Sheffield cutleries. Another considerable market is at Antwerp. The annual exports of ivory from Africa represent the product of sixty thousand elephants, and this means a rapid reduction of the elephantine population of the continent. Various artificial ivories, or imitations, are manufactured to supply the increasing demand. There are vegetable ivory—tagua seed from Peru, or wood injected with chloride of lime; sheep bone, macerated with the wastes of white skins; paper pulp with gelatin, celluloid, and caoutchouc; a preparation of potatoes; and a substance obtained by treating milk with certain reagents. The expediency has been suggested of establishing elephant farms, to form a more certain source of supply than hunting wild elephants is destined to become. Ostrich farming has proved practicable; why not elephant farming too?

Migration of Birds.—On the solution of the problem of the migration of birds, Canon Tristram said in the British Association, much less aid has been contributed by the observations of field naturalists than might reasonably have been expected. The observable facts may be classified as to their bearing on the whither, when, and how of migration, and after this we may possibly arrive at a true answer to the Why? Observation has sufficiently answered the first question, Whither? There are scarcely any feathered denizens of earth or sea to the summer and winter ranges of which we can not now point. Of almost all the birds of the holo-arctic fauna we have ascertained the breeding places and the winter resorts. Now that the knot and the sanderling have been successfully pursued even to Grinnell Land, there remains but the curlew sandpiper of all the known European birds whose breeding ground is a virgin soil, to be trodden, let us hope, in a successful exploration by Nansen, on one side or other of the north pole. Equally clearly ascertained are the winter quarters of all the migrants. The most casual observer can not fail to notice in any part of Africa, north or south, west coast or interior, the myriads of familiar species which winter there. We have arrived at a fair knowledge of the When? of migration. Of the How? we have ascertained a little, but very little. The lines of migration vary widely in different species and in different longitudes. All courses of rivers of importance form minor routes. Consideration of all lines of migration might serve to explain the fact of North American stragglers, the waifs and strays which have fallen in with great flights of the regular migrants, and been more frequently shot on the east coast of England and Scotland than on the west coast or in Ireland. They have not crossed the Atlantic, but have come from

the far north, where a very slight deflection east or west might alter their whole course, and in that case they would naturally strike either Iceland or the west coast of Norway, and in either case would reach the east coast of Britain. But, if by storms and the prevailing winds of the North Atlantic coming from the west, they had been driven out of their usual course, they would strike the coast of Norway, and so find their way to Britain in the company of their congeners. It is maintained that the height of flight is some fifteen hundred feet to fifteen thousand feet.

The Atlas Mountains.—The great chain of the Atlas forms a mountain system which is described by Charles Rolleston as, for the grandeur and beauty of its romantic scenery, not to be surpassed, perhaps, by any in the African continent. The range extends into the adjacent French possessions in Algeria, but in Morocco its length is about three hundred miles, of which thirty miles, stretching from the sources of the river known as the Ouad Tissout, attain a general elevation of about twelve thousand feet. On approaching this imposing mountain line the aspect is truly sublime. At the time of early dawn of certain seasons the heights are imbedded in masses of white mist, which, under the influence of the rising sun, dissolve with the appearance of a thin, gauzy veil, disclosing a magnificent panorama of mountains rising behind mountains. Toward the Atlantic on the outer side, and in the direction of Algeria on the other, a broad line of snow edges the mountain tops; and at intervals loftier snow-clad peaks tower up, piercing the background of dark blue sky. Just below the region of snow the mountain sides are intersected by broad valleys bounded by wild, craggy heights; but lower still, where vegetation begins, the slopes are furnished with forests, stretching at places into long expanses of parklike woodland of pine, oak, walnut, and larch trees, growing with wonderful luxuriance. The view of the landscape, looking down five thousand or six thousand feet, is variegated and beautiful, for, watered by thousands of rivulets pouring from the base of the Atlas, there stretch away miles of fertile country strewn with Berber hamlets, plantations, and fruit orchards, the deep-green grass land and cultivated fields diversified with gardens and groves of orange, lemon, palm, and myrtle, producing the most charming harmony, combination, and contrast of coloring as far as the horizon, and the whole together presenting a landscape of the most enchanting beauty.

Women Astronomers.—Of six famous women mathematicians and astronomers whose work is mentioned by M. A. Rebière in a recent communication, the first, Hypatia, daughter of Theon, of Alexandria, lived in the fourth century, publicly taught mathematics and philosophy to large classes, and wrote treatises on mathematics. From her the author comes down to Madame du Châtelet, in the eighteenth century, a mathematician, astronomer, and physician, who in a memoir on fire, in the French Academy of Sciences, maintained that heat and light were produced by the same cause. Other women mathematicians mentioned by M. Rebière are Marie Agnesi, born at Milan in 1718; Sophie Germain, who, at the end of the last century corresponded with the mathematician Montucha; Mary Somerville, the friend of Laplace and a student of astronomy and physics during her whole life; and Sophie Kowaleski, born at Moscow in 1850, whose work on the rings of Saturn has been complemented by that of Mademoiselle Klumpke, of the Paris Observatory. Besides these, *La Nature*, in its supplement, names a number of less-known women who have attained a larger or smaller degree of distinction by their labors in this field. The Abbess Herrade, in the twelfth century, was author of a cosmology, the *Hortus deliciarum;* in the same century, Sainte Hildegarde gave, in her *De Physica*, a summary of the sciences of her time. In the thirteenth century, Nontis Sabucco described the function of the white matter of the brain. In the fourteenth century, Thiephaine Raguenel, wife of Duguesclin, was "learned in astronomy." Eimart-Meller, wife of Regiomanes, assisted him in his observations. Croris advocated the decimal system; Dumée defended the Copernican theory; Cunitz calculated the astronomical tables called *Urania propitia;* Ardingheli published works on mathematics and natural science; Bassi taught physics in the University of Bologna for thirty years; Le-

mère studied the quadrature of the circle; Mésian went to Guiana and published an important book on the insects of Surinam. Maria Mitchell and Yvon Villarceau were well-known astronomers; and among contemporary women of science in different nations the names of Agnes Clarke and Clemence Royer are those of foreign workers best known to our readers.

College Athletics and Health.—Speaking, in an address on the Influence of College Life on Health, of College Athletes, Dr. Edwin Farnham says that "they are, as compared with the whole number of students, but few, and must always be so; for the true athlete, like every real artist, is born, not made. Much has been written about training, as if by some mysterious process an athlete could be developed out of any sort of material. As I understand training, it is a process by which a man is put into a condition which enables him to make the greatest skilled muscular effort of which he is capable, in a certain way, for a certain time. It may be beneficial to health, but that is not its object. You must have the proper material to work upon, or all the training in the world will be of no avail. At many colleges large sums of money have been spent on the various preparations necessary for athletic contests, and a great deal of time and labor devoted to them. At some colleges special privileges have been granted to the men composing the athletic teams. Has an equal amount of attention been given to the care of the health of the students, considered in the light of a subject in no way connected with muscular development? What I know about this matter relates mainly to Harvard University, but I am disposed to think that other colleges would not be found superior to Harvard in this respect. I am, and for more than thirty years have been, interested in athletic sports, but I hold it true that the first duty of a great educational institution is to the scholar — not to his intellectual needs alone, but to everything that makes for the preservation and improvement of health as well. None can know better than the body of physicians here assembled that the use which a man may be able to make in his life work of the knowledge acquired during his school and college days will depend largely on the condition of his health. Physical exercise has been a mania for some time, and much nonsense has been written about it. Even so great an authority as Dr. Parkes says, in his Practical Hygiene, 'Exercise is a paramount condition of health, and the healthiest persons are those who have most of it.' Exercise in the proper amount is indeed one of the means conducive to the preservation and improvement of health, but there are others as important, and some more so. The scholar should always bear in mind that in his case exercise is intended as a means to health which shall enable him to do his proper work in the best manner. He should never try to combine great mental with great bodily labor. I feel sure, from personal experience and from what prominent athletes have told me, that this can not be done with safety."

Archæology at the University of Pennsylvania.—The purposes of the department of Archæology and Paleontology of the University of Pennsylvania are to provide instruction in those subjects and in ethnology, and to extend scientific inquiry by means of original investigation in them. It will accomplish this by means of a library, courses of lectures, and the sending out of exploring expeditions. In the section of Babylonian antiquities excavations have been continuously carried on at Niffur, Mesopotamia; the Temple of Bel there has been nearly uncovered, many inscribed stones, cuneiform tablets, etc., of 4000 years B. C. have been obtained, and a collection of inscriptions published; and Dr. H. V. Hilprecht has spent five weeks in examining the cuneiform inscriptions collected at Constantinople. In the Egyptian section lectures have been delivered by Mr. Cornelius Stevenson; an exhibition of the Graf collection of rare Græco-Egyptian portraits and other objects has been secured. In the section of Glyptology special provision has been made for the Summerville collection of gems and talismans and it has been considerably increased; while no opportunity has been neglected that might afford new acquisitions. A section of casts has been established, and arrangements have been made for filling it. A collection of photographs illustrating archæological objects at Copan, Honduras, has been obtained.

The section of Asia and General Ethnology was formed in January, 1894, and has been enriched with a collection of Oriental games, an important series from the Sultan of Johore, Chinese porcelain images; masks, weapons, etc., from Ceylon; games of all countries, military banners from Corea, and Indo-Greek sculpture, from Afghanistan. The archæological library has grown in one year from a collection of four hundred to one of eighteen hundred volumes.

Oriental Silver Work.—Silver, according to our consul at Amoy, is to the Eastern Asiatics as gold to us, and is worked up by them into innumerable articles of curio and bric-a-brac. One class of designs consists of miniature reproductions of features of daily life, including articles of household and personal use, the goddess of mercy, the Celestial Porole, the King of the Fishes, the sitting Buddha, the dragon, the flying serpent, the begging priest, and animals of all sorts. The largest of these articles do not exceed two inches in length, and they diminish to dainty little objects no larger than a grain of corn. The work and finish are admirable, and the features and hair of the human beings and the scales of the fishes and crocodiles are reproduced with the highest care and skill. Another class of these objects consists of miniature cordage. The metal is solid, but the surface is so cleverly wrought out that at first sight each piece seems a rope, cord, or braid. Some of them are as fine as sewing silk, while others are as thick as clotheslines. These silver cords are used for bracelets, anklets, necklaces, belts, sword hangings, and horses' harness. Though stiff, they are not rigid, and can be bent in any direction. A third class of articles includes household ornaments, such as match boxes, ash cups, joss sticks, bowls, sandalwood urns, plates for opium pipes, button boxes, and so on without end. A fourth class includes filigree work and tissues made from fine silver ware, all marked by the highest skill and beauty. Articles of this class, brought by Marco Polo to Venice, are supposed to have suggested the Italian filigree industry. A design from Fuchan is a bouquet, over which is loosely wrapped a silken veil. It was so perfectly made that the veil looked as though it might blow away at any moment. Through its flimsy folds the flowers and leaves were all visible. Another artistic gem is a little bouquet in which ferns, lilies of the valley, and other plants are completely represented in metals.

NOTES.

Mr. Gerard Fowke calls attention to the fact that, while Ohio has furnished prehistoric articles and relics for hundreds of collections at home and in Europe, and still possesses material to furnish specimens exceeding in number those of all collections combined of American archæology, the State has no adequate collection of its own accessible to all the public. The opportunity to form such a collection is now afforded through the new geological building of the State University, where should be established "the nucleus of a museum of Ohio archæology that would properly represent the great wealth of prehistoric remains within her borders." These remains should be gathered up industriously, "for they are being as slowly but as surely blotted out as are the aboriginal conditions of life which gave them existence."

Prof. Riley read a paper in the British Association on Social Insects and Evolution. He gave an account of the different kinds of individuals in the communities of bees and ants, and pointed out differences which indicated a gradation in the degree of their development. In the colonies of white ants the production of different kinds of individuals was even more under the control of the community. There were also many variations in different species: some had no soldiers; others, supplementary and complementary kings and queens, which were capable of reproduction in their pupal and larval stages. They fed, among other things, on their dead companions, and hence might be destroyed by poisoning a few, who in their turn poisoned their cannibal fellows. In these and other cases which were adduced the competition was between colonies, not between individuals, and, on the whole, the evidence drawn from these insects is in favor of the transmission of acquired characters.

The name Mashona (in Mashonaland) was explained by a Mr. Drule in the British Association as an English corruption of the nickname Amashuina (baboons) given by the Matabele to the Makalanga.

Great interest was awakened in the British Association by the communication of Lord Rayleigh and Prof. Ramsay on a new gas occurring in the atmosphere. Attention was first called to this substance by the fact that the density of nitrogen obtained from atmospheric air differed by about one

half per cent from the density of nitrogen obtained from other sources. It was found that if air is subjected to electric sparks, the resulting nitrous fumes absorbed by potash and the excess of oxygen by alkaline pyrogallate, there remains a residue which is neither oxygen nor nitrogen, as can be seen from its spectrum. The same gas may be isolated by exposing nitrogen obtained from the air to the action of magnesium. As the magnesium gradually absorbs the nitrogen, the density of the residue rises to nearly twenty. The newly discovered substance constitutes one per cent of the atmosphere, and gives a spectrum with a single blue line much more intense than a corresponding line in the nitrogen spectrum. Prof. Dewar is of the opinion that this "new element" is an allotropic form of nitrogen.

LIVERPOOL was designated as the place for the meeting of the British Association in 1896. Sir Douglas Galton will be president of the meeting at Ipswich next year. The meeting for 1897 will probably be held in Toronto.

PROF. T. JOHNSON exhibited in the British Association a large collection of algæ from the west coast of Ireland which have the power of strongly incrusting their tissues with chalk and forming hard masses of calcareous matter. He considered that by this means the algæ obtained protection from the ravages of nibbling animals. He also described a number of algæ which possess an entirely opposite property, and by their power of dissolving calcareous matter bore minute holes in the shells of various molluscs and thus completely destroyed them.

PROF. L. H. PAMMEL, in a paper on the Effects of Cross-Fertilization in Plants, cites experiments by Prof. Bailey, of Missouri, who obtained more than a thousand types of pumpkins and squashes by as many careful hand pollinations without having ever seen any influence on the season's crop by mixing, except such as was due to imperfect development. The effects of the pollen were seen only in the offspring of the fruits. The author himself had made similar experiments without obtaining any results favorable to the theory of immediate influence. Prof. Bailey has made a like report of experiments with cucumbers and muskmelons.

IN a paper read in the Association of Economic Entomologists on The Rise and Present Status of Official Economic Entomology, President L. O. Howard reviewed the entire history of official economic entomology in all parts of the world from the time when in the early part of the century Dr. T. W. Harris, of Harvard College, wrote his report on insects injurious to vegetation in Massachusetts, for which he received one hundred and seventy-five dollars, down to the present year, when the United States Government spends one hundred thousand dollars annually in employing some sixty official entomologists in different parts of the country, and when some twenty different countries in all parts of the world have reached the conclusion that it pays to employ trained investigators to study the subject of insects injurious to crops. The speaker asserted that America leads the rest of the world in this branch of applied science.

THE University of Chicago desires to secure for its museum collections illustrating the various religions of mankind, and invites workers in foreign lands, and especially missionaries and teachers, to assist it and co-operate with it. A beginning has already been made in a collection which the university now holds as a loan of objects illustrating Shinto worship and Japanese Buddhism, gathered by Mr. Edmund Buckley in Japan. A catalogue of the Shinto specimens is published in illustration of the kind of objects sought, and for the guidance of persons who may wish to co-operate in the work of collecting.

A COURSE of lectures on prehistoric archæology, outlined by Prof. Frederick Starr for the University Extension Course of the University of Chicago, is to embrace twelve lectures. A syllabus has been published of the first six lectures, the subjects of which are Man and the River Gravels, The Man of the Caverns, The Stone Age in Denmark, Lake Dwellings of Switzerland, Megalithic Monuments, and The Bronze Age in Scandinavia. The subjects of the other six lectures, of which a second syllabus is to be published, are Hallstadt, La Téne, Spain and Portugal, The Copper Age in Hungary, The Hill of Hissarlik, and The Question of Tertiary Man. Topics for exercises are to be given at the end of each lecture, to which answers in writing, to not more than two questions each week, are invited from all persons attending the lecture.

IN a paper on The Relation of Biology to Geological Investigation, Dr. Charles A. White, of the United States National Museum, pertinently observes that a special cause of the perpetuation of extreme views respecting the degree of prominence to be assigned to biology "evidently exists in the form of personal domination by such of those who entertain them as happen to possess unusual opportunities for their enforcement. It is well known that such influence has at various times and in various ways retarded the progress of geological science, and that there is danger of its being exercised in all cases when the personal judgment of an observer is liable to be modified or controlled by official or other temporary authority."

OIL of beechnuts and oil of linden seeds have for some time been manufactured in Germany for use instead of olive oil. The oil of beechnuts has been in active demand

for several years, but the crop is uncertain, and a steady trade has therefore not been built up. Experiments were made with linden seeds, of which there never fails to be a good crop, with most satisfactory success. They furnish much more oil than beechnuts; an oil that has a peculiarly fine flavor, does not evaporate or become rancid, has no tendency to oxidation, and does not solidify at a temperature of three degrees below zero of Fahrenheit.

OBITUARY NOTES.

THE eminent physicist Hermann Ludwig Ferdinand von Helmholtz died, after a second stroke of paralysis, at Charlottenburg, Prussia, September 9th, in the seventy-fourth year of his age. The outlines of his early life and labors, including his principal researches into the nature of the phenomena of light and sound, the enunciation of the principle of the conservation of force, and the invention of the ophthalmoscope, were given in the fifth volume of the Monthly (June, 1874). His labors since were on like lines, and various, in the fields of mathematics, physics, physiology, psychology, etc. They involved questions of vortex motion, the discontinuity of motion in liquids, the vibrations of sound at the open ends of organ pipes, thermodynamics, electrodynamics, stereoscopic vision, galvanic polarization, the theory of anomalous dispersion, the origin and meaning of geometrical axioms, the mechanical conditions governing the motions of the atmosphere, metaphysics, and mental science. On all these subjects he shed a clearer light than the world had enjoyed before, and in some he made order out of chaos. The event of his seventieth birthday, in 1891, was made the occasion of an international celebration, when the principal rulers of Europe and the scientific institutions of the world vied in conferring their honors upon him. "Science," says Nature, "has had few investigators who have furthered her interests more than Helmholtz. He was constantly exploring new fields of research, or bringing his keen intellect to bear upon old ones. With his contributions he helped to raise science to a higher level." Like other real masters of science, he believed in making it intelligible to the whole intellectual world, and did so. He was ready to recognize the merits and acknowledge the achievements of other workers in the fields he cultivated; and while he did not always keep out of controversies, he so bore himself when engaged in them as to show that his sole desire was to establish the truth.

PROF. JOSIAH PARSONS COOKE, of Harvard University, died at his summer home in Newport, R. I., September 3d, after an illness of about one month. He was graduated from Harvard College in 1848, and, having served for two years as an instructor, he was appointed Erving Professor in the same institution in 1857. He rearranged the system of instruction in chemistry in the institution and brought it up to its present high state of efficiency. He was the author of several important books and papers in chemistry and qualitative analysis, among which may be mentioned The New Chemistry in the International Scientific Series, and a Manual of Laboratory Practice. One of his best published papers was a plea for a broader education of men of science. He was a president of the American Academy of Arts and Sciences. A portrait and sketch of him were published in The Popular Science Monthly for February, 1877.

GEORGE HUNTINGTON WILLIAMS, Professor of Inorganic Geology in Johns Hopkins University, died of typhoid fever July 12th. He was born in Utica, N. Y., and was graduated from Amherst College in 1878. He resided for a short time in Berlin, and afterward studied under Rosenbush in the University of Heidelberg, where he obtained the degree of Ph. D. in 1882. He was associate professor at Johns Hopkins University from 1885 till 1892, and after that full professor. He was author of a book on the Geology of Maryland, a text-book on crystallography, and several memoirs on petrography, and was preparing at the time of his death a work on the microscopic structure of American crystalline rocks.

PROF. H. K. BRUGSCH, a distinguished philologist, and one of the most eminent of Egyptologists, died September 9th, aged sixty-seven years. He was for many years an officer in the Egyptian service, where he held the rank of bey, and devoted much time to archæological exploration and the study of the Egyptian records. His History of Egypt is one of the best of the works at first hand on that subject.

THE British naval commander, Sir Edward Augustus Inglefield, a distinguished arctic navigator and explorer, died early in September, at the age of seventy-four years. During a voyage in the Isabel, on private account, in search of Sir John Franklin, he discovered an open polar sea and traced a coast line eight hundred miles long. From another expedition sent for the relief of Sir Edward Belcher in 1853, an officer returned with him bearing the news of the discovery of the northwest passage. With a third expedition he brought home the officers and crews of five ships which had been abandoned in the ice. For these services he received the arctic medal, and was knighted at the fiftieth anniversary celebration of her Majesty's reign. He devised a hydraulic steering apparatus, a screw-turning engine, and an anchor, which were used on various vessels. He was author of the books A Summer Search for Sir John Franklin, Maritime Warfare, Naval Tactics, and Terrestrial Magnetism.